

# SCHOOL OF CIVIL ENGINEERING

Elviña Campus, A Coruña

Updated: July 2005

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## Academic Calendar:

The academic period understands from October to the end of September (October 2<sup>nd</sup> to September 29<sup>th</sup>). There will be no lectures on local holidays, and during the celebration of Santo Tomás de Aquino and the Patron of the faculties. <http://www.udc.es/estudos/ga/temasacademicos/>

## Presentation and Historical Precedents:

The School of Civil Engineering of the University of A Coruña was created by the Decree 274/1991 of July 30<sup>th</sup>, issued by the “Consellería de Educación e Ordenación Universitaria” of the “Xunta de Galicia”, which furthermore granted the authorisation to set up the studies leading to the official degree of “Ingeniero de Caminos, Canales y Puertos”.

The school began its academic activities in October 1991, provisionally located in the “Laboratorio de Control de Calidad de la Demarcación de Carreteras del Estado” in Galicia, dependent on the Ministry of Public Works, in the locality of Arteixo.

The School of Civil Engineering is located at the entrance of the Elviña Campus. Inaugurated on 13th January 1994, it is a single building of 16,000 square metres separated into two wings, connected by a hall, which constitutes the access to the School. Here we find the cafeteria and the auditorium, with a capacity for four hundred people.

Below a relation of the Departments of the School grouped according to their field of activity or work group:

- Construction Technology
- Mathematical and Representation Methods
- Architectural Projects and Urbanism
- Energy and Maritime Propulsion
- Industrial Engineering
- Applied Economics I
- English Philology
- Computing Science
- Composition

**Language of instruction:** Gallego / Spanish

# CIVIL ENGINEERING

Studies leading to the official degree of Civil Engineer, providing suitable scientific training in the theoretical principles and technological features of this discipline.

## CAREER POSSIBILITIES

**SECTORS:** Public works. Construction, transport and communication Companies. Electricity and electronics companies. Ministries of Public Works, of Environment, of Defence, and of Education and Culture.

**FUNCTIONS:** Project and execution of surface and underground (foundations, sewers, water supply, etc.) construction works. Urbanism and traffic (streets, roads, railways, piping parking lots, ports and airports). Hydraulic installations and works (in rivers, dams and hydraulic centres). Company management, transport planning and management of resources.

SYLLABUS 632 011		
<b>Date of Confirmation:</b> 20/9/91 and 24/7/96	<b>Date of Publication in B.O.E.:</b> 17/1/92 and 7/2/97	<b>Year of Initiation:</b> 91/92

DISTRIBUTION OF CREDITS							
Cycle	Year	Core (ECTS)	Compulsory (ECTS)	Optional (ECTS)	Free Configuration (ECTS)	F.P.	Total (ECTS)
1º	1º	78 (56)	- (-)	- (-)	6 (4)	-	84 (60)
	2º	75 (56)	- (-)	- (-)	6 (4)	-	81 (60)
2º	3º	51 (37.5)	21 (14.5)	6 (4)	6 (4)	-	84 (60)
	4º	54 (40)	- (-)	18 (12)	12 (8)	-	84 (60)
	5º	33 (22)	6 (4)	30 (20)	12 (8)	6 (6)	87 (60)
<b>TOTAL</b>		<b>291 (211.5)</b>	<b>27 (18.5)</b>	<b>54 (36)</b>	<b>42 (28)</b>	<b>6 (6)</b>	<b>420 (300)</b>

**FINAL PROJECT:** Yes

**EQUIVALENT CREDITS:** Up to 18 optional credits:

- Up to 6 credits through practical work in companies, public or private institutions, etc  
*Equivalence:* Minimum of 60 hours in one month.
- Up to 12 credits through technical project.

**ACCESS TO THE 2nd CYCLE (From other courses) (10/12/93 Order, B.O.E. 27/12/93)***Direct:*

- Technical Engineer in Public Works: Specialist in Civil Constructions
- Technical Engineer in Public Works: Specialist in Transport and Urban Services
- Technical Engineer in Public Works: Specialist in Hydrology

*With Complementary Training*

- Technical Engineer in Mining: Specialist in Mine Organisation
- Technical Engineer in Mining: Specialist in Mine Drilling and Prospecting
- Students who have passed the first cycle of Mine Engineering.

Hydraulics and Hydrology	9 c.
Transport and Territory	6 c.
Metric and Descriptive Geometry	6 c.

**ACCESS TO OTHER COURSES****After completing this course, the student will have access to:**

- Material Engineering (Complements B.O.E. 28/9/95)
- Mine Engineering (Complements B.O.E. 29/12/93)
- Industrial Organisation Engineering (Complements B.O.E. 28/9/95)
- Environmental Sciences Engineering (Complements B.O.E. 28/9/95)
- Graduate in Statistical Science and Techniques (Complements B.O.E. 28/9/95)
- Graduate in Market Research and Techniques (Complements B.O.E. 26/9/91 and 1/6/94)
- Audio-visual Communications (B.O.E. 12/6/92), Documentation (B.O.E. 5/8/93), Advertising and Public Relations (B.O.E. 12/6/92), Journalism (B.O.E. 12/6/92), History and Music Science (B.O.E. 28/9/95), Humanities (B.O.E. 27/12/93), Linguistics (B.O.E. 13/1/93) and Translation and Interpretation (B.O.E. 27/12/93).

**SYLLABUS ORGANIZATION**

Code	Type	SUBJECT	Credit (ECTS)	Theory	Practical
<b>FIRST CYCLE</b>					
FIRST YEAR					
101	T	<b>Álgebra (A)</b>  <i>Description:</i> Linear algebra. Fundamentals of statistics.  <i>Aims:</i> To know and to understand linear algebra in such a way that makes possible its use in other subjects.  <i>Syllabus:</i> 1. Basic operational concepts. 2. Vector spaces. 3. Finite-dimensional euclidean vector spaces. 4. Affine spaces. 5. Conics and quadrics.  <i>Bibliography:</i> <ul style="list-style-type: none"> <li>• <i>Álgebra Lineal</i>, Juan de Burgos, Editorial Mc-Graw-Hill, Madrid, 1993.</li> <li>• <i>Álgebra vectorial y Tensorial</i>, Fuente, Salet y Cruces, Editado por Servicio de Publicaciones de la E.T.S.I.C.C.P., Madrid, 1980.</li> <li>• <i>Lecciones de Álgebra y Geometría</i>, Alsina y Trillas, Editorial Gustavo-Gili, Barcelona, 1984.</li> <li>• <i>Problemas de Álgebra</i>, A. de la Villa, Editorial CLAGSA, Madrid, 1994.</li> <li>• <i>Problemas de Álgebra</i> (Tomos 3, 6 y 7), Anzola, Caruncho y Pérez-Canales, Madrid, 1981.</li> </ul>	15  (10.5)	7.5	7.5

		<ul style="list-style-type: none"> <li>• <i>Problemas de Estructuras Algebraicas Tensoriales</i>, González de Posada, Madrid, 1971.</li> <li>• <i>Problemas de cálculo de probabilidades</i>, J. Pérez Vilaplana. Paraninfo, 1991.</li> <li>• <i>Teoría y problemas de probabilidad</i>, S. Lipschutz, M. L. Lipson. McGraw-Hill, 2000.</li> <li>• <i>Álgebra lineal y ecuaciones diferenciales con MatLab</i>, M. Golubitsky. Thomson, 2001.</li> <li>• <i>MatLab edición del estudiante: guía del usuario</i>,. Prentice Hall, 2001.</li> </ul> <p><i>Teaching organization:</i> Lectures take up 5 hours per week, 3 of them theoretical and 2 of them practical.</p> <p><i>Assessment:</i> Two partial examinations, and final exams in June and September. To pass “by course”, it is required to achieve a fixed mark in each partial examination.</p> <p><i>Teacher:</i> Luis Fuentes García y Ángel Daniel</p>			
102	T	<p><b>Calculus I (A)</b></p> <p><i>Description:</i> Infinitesimal calculus. Integration.</p> <p><i>Aims:</i> To provide the students with a solid basis for the resolving of the mathematical problems which they are going to meet during their studies or in the professional field.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. The real number</li> <li>2. Metric and topological spaces.</li> <li>3. Sequences in R</li> <li>4. Functions in R.</li> <li>5. Integration.</li> <li>6. Vectorial functions.</li> <li>7. Series.</li> <li>8. Sequences and functional series.</li> <li>9. Complex numbers.</li> </ol> <p><i>Bibliography :</i></p> <ul style="list-style-type: none"> <li>• <i>Introducción al Cálculo. Problemas y ejercicios resueltos</i>; Franco, J.R.; Ed. Prentice Hall; Madrid, 2003.</li> <li>• <i>Cálculo Infinitesimal. Una y varias variables</i>; Granero, F.; Ed. Mc Graw-Hill; Madrid, 1996.</li> <li>• <i>Cálculo Infinitesimal de una variable</i>; Burgos, J.; Ed. Mc Graw-Hill; Madrid, 1994.</li> <li>• <i>Guía práctica de Cálculo Infinitesimal en una variable real</i>; Galindo, F. y otros; Ed. Thomson; Madrid 2003.</li> <li>• <i>Ejercicios y problemas de Cálculo</i>; Granero, F.; Ed. Tébar Flores; Albacete, 1991.</li> <li>• <i>Cálculo I. Teoría y problemas de Análisis Matemático en una variable</i>; García, A. y otros; Ed. CLAGSA; Madrid, 1998.</li> <li>• <i>Cálculo II. Teoría y problemas de funciones de varias variables</i>; García, A. y otros; Ed. CLAGSA; Madrid, 2003.</li> <li>• <i>Cálculo de varias variables. Problemas y ejercicios resueltos</i>; Besada, M. y otros; Ed. Prentice Hall; Madrid, 2001.</li> <li>• <i>Cálculo Vectorial</i>; Marsden, J.; Tromba, A.; Ed. Pearson-Addison Wesley, Madrid, 2004.</li> <li>• <i>Cálculo Integral y aplicaciones</i>; Granero, F.; Ed. Prentice Hall; Madrid, 2001.</li> <li>• <i>Cálculo Integral. Metodología y problemas</i>; Coquillat, F.; Ed. Tébar Flores; Albacete, 1980.</li> </ul> <p><i>Teaching organization:</i> Every week, two theoretical and three practical sessions are imparted. During the latter, previously proposed problems are solved. One of the practical sessions is devoted to the resolution of integrals. A collection of examination problems, integrals and theoretical questions is at the students disposal.</p> <p><i>Assessment:</i> Besides the June and September examinations, two partial exams are held. In the partial exams, an average mark of 5 out of 10, with a minimum of 3.5 in each, is necessary to pass. In the June and September examinations a mark of 5 out of 10 is necessary to pass. All the subjects given from the beginning of the course until the moment of the examination form part of the examination.</p> <p><i>Teacher:</i> Jaime Fe Marqués, Gonzalo Mosqueira Martínez, Raquel López Jato.</p>	15  (10.5)	7.5	7.5

103	T	<p><b>Technical Drawing (A)</b></p> <p><i>Description:</i> Technical drawings. Representation systems.</p> <p><i>Aims:</i> Acquisition and development of spatial vision and the techniques to be reflected in the plan. Acquiring the layout techniques of lineal and platform works. Applying the knowledge of Technical Drawing to the sketching and cubic measurement of the pieces related to Public Works, for its knowledge, understanding and familiarization, carrying it out with the necessary rapidity and quality.</p> <p><i>Syllabus:</i>  A. Theory  I. Representation systems.  1. Introduction to the concept of descriptive geometry.  2. Generalities of dihedral system.  3. Generalities of a contour system.  4. Generalities of the axonometric system.  5. Generalities of central projection.  II. Development of parallel projection  6. The point and the straight line in parallel projection.  7. Representation of the plane. Flat figures.  8. Intersections.  9. Intersection in a contour system.  10. Elements of the theory of shadows.  B. Practical Lectures  1. Study of forms.  2. Measuring and construction details</p> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Geometría Descriptiva.</i>, Izquierdo Asensi, F., Editorial Paraninfo, Madrid, 1995.</li> <li>• <i>Geometría Descriptiva.</i>, Leighton Wellman, B., Editorial Reverte, Barcelona 1987.</li> <li>• <i>Geometría Descriptiva: I Sistema Diédrico.</i>, Rodríguez Abajo, F.J., Revilla, A. Editorial Donostiarra, San Sebastián, 1992.</li> <li>• <i>Geometría Descriptiva: II Sistema Acotado.</i>, Rodríguez Abajo, FJ. Editorial Donostiarra, San Sebastián, 1993.</li> <li>• <i>Geometría Descriptiva: III Sistema de perspectiva Axonométrica.</i>, Rodríguez Abajo, FJ. Álvarez V. Editorial Donostiarra, San Sebastián, 1995.</li> <li>• <i>Geometría Descriptiva: IV Sistema de perspectiva Caballera.</i>, Rodríguez Abajo, FJ. Revilla A.. Editorial Donostiarra, San Sebastián, 1993.</li> <li>• <i>Geometría Descriptiva: Sistema Cónico.</i>, Rodríguez Abajo. Editorial Donostiarra, San Sebastián, 1990</li> <li>• <i>Dibujo Técnico.</i>, Rodríguez Abajo, F.J., Álvarez V. Editorial Donostiarra, San Sebastián. 1984.</li> <li>• <i>Dibujo Técnico.</i>, Ramos, B; García, E. Ed .AENOR, Madrid 1995</li> <li>• <i>Dibujo Técnico. Construcción y obra civil</i>, Ramos, B; García, E. Ed .AENOR, Madrid 1999</li> <li>• <i>Método y aplicación de representación acotada y del terreno</i>, Gentil Baldrich, JM. Editorial Bellisco, Madrid 1998.</li> <li>• <i>Geometría Descriptiva. Sistema Acotado</i>, Martín de Morejón, L., E.U.A.T. de Madrid, Barcelona, 1985.</li> <li>• <i>Dibujo Técnico de Ingeniería</i>, Campos Asenjo, J., Ediciones Campos, Madrid, 1965.</li> <li>• <i>Dibujo Técnico. Introducción a los Sistemas de Representación</i>, Palencia, J., E.T.S.I.C.C.P., Madrid, 1986.</li> <li>• <i>Sistema de planos acotados</i>, Collado Sánchez, V; Editorial Tebar Florez, Madrid 1984</li> <li>• <i>Ejercicios de Geometría Descriptiva I. Sistema diédrico.</i>, Izquierdo Asensi, F., Editorial Paraninfo, Madrid, 1994.</li> <li>• <i>Ejercicios de Geometría Descriptiva II. Acotado y axonométrico.</i>, Izquierdo Asensi, F., Editorial Paraninfo, Madrid, 1994.</li> <li>• <i>Problemas de Geometría Descriptiva.</i>, Rodríguez Abajo, F.J., Editorial Marfil, Alcoy, 1996.</li> </ul> <p><i>Teaching organization:</i> The lectures are divided into 2 theoretical sessions per week and another two sessions of practical lectures classes. The topics of the program are organized in two parts: an A part of Theoretical Technical Drawing and a B part of Practical Technical Drawing.</p> <p><i>Assessment:</i> There will be two partial exams, and the final exams corresponding to the exam period of June and September.</p>	12  (9)	6	6
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		<i>Teacher:</i> Julia Álvarez García y José M. Solas Alados			
104	T	<p><b>Applied Physics (A)</b></p> <p><i>Description:</i> Elementary mechanics. Wave phenomenon. Electricity. Thermodynamics.</p> <p><i>Aims:</i> To supply the student with the fundamental knowledge of Applied Physics, in order to face subjects of the next courses, and to solve basic problems of physics in civil engineering.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Vector systems.</li> <li>2. Particle mechanics.</li> <li>3. Geometry of mass point particles.</li> <li>4. Mechanics of rigid bodies.</li> <li>5. Elasticity.</li> <li>6. Fluid mechanics.</li> <li>7. Thermodynamics.</li> <li>8. Wave phenomenon.</li> <li>9. Electromagnetic interactions.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Física (2 Vol.)</i>, Serway, R. A., Mc Graw-Hill Interamericana Editores, Méjico, 1997 (cuarta edición).</li> <li>• <i>Física para la ciencia y la tecnología (2 Vol.)</i>, Tipler, Paul A., Editorial Reverté. España 1999 (cuarta edición).</li> <li>• <i>Física Universitaria (2 Vol.)</i>, Sears, F.W., Zemansky M.W., Young H.P., Freedman R.A., Addison Wesley Longman de México. México 1999 (novena edición).</li> <li>• <i>Mecánica vectorial para ingenieros (2 Vol.)</i>, Beer, F.P. y Johnston, E.R., Mc Graw-Hill Interamericana de España, Madrid, 1997 (sexta edición).</li> <li>• <i>Física, Vol.1: Mecánica, Vol.2: Campos y Ondas</i>, Alonso, M. y Finn, E.J., Addison-Wesley Iberoamericana, Estados Unidos 1987</li> <li>• <i>Curso de termodinámica</i>, Aguilar, J., Alhambra-Longman, Madrid, 1998.</li> </ul> <p><i>Teaching organization:</i> In general there will be three hours per week of theory lectures and two hours per week of practical ones. Laboratory practical lectures will be also held in small groups.</p> <p><i>Assessment:</i> There will be two assessment examinations covering part of the course and two final examinations in June and September. In order to pass it is necessary to obtain a minimum mark in both partial exams and also to carry out the laboratory practical lectures.</p> <p><i>Teacher:</i> Enrique Peña González, Félix Nieto Mouronte, Arturo N. Fontán Pérez</p>	15  (10.5)	6	9
105	T	<p><b>Construction Materials (A)</b></p> <p><i>Description:</i> Fundamentals of science and materials technology. Construction materials.</p> <p><i>Aims:</i> The course is designed to give theoretical and practical knowledge of physical, chemical, mechanical and technological properties of those materials most commonly used in Civil Engineering and thus learn how to use them correctly.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. General properties of materials.</li> <li>2. Natural rocks.</li> <li>3. Ceramic materials.</li> <li>4. Plasters.</li> <li>5. Lime.</li> <li>6. Cements.</li> <li>7. Concrete.</li> <li>8. Bituminous materials.</li> <li>9. Metallic materials.</li> <li>10. Polymers.</li> <li>11. Timber and cork.</li> </ol>	12  (9)	6	6

		<p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Materiales de Construcción</i>, Camuñas, A., Guadiana de Publicaciones, Madrid, 1974.</li> <li>• <i>El Cemento Portland y otros aglomerantes</i>, Gomá, F., Editores Técnicos Asociados, Barcelona, 1979.</li> <li>• <i>Hormigón</i>, Fernández, M., Serv. de Publicaciones R.O.P. E.T.S.I. Caminos, Madrid, 1991.</li> <li>• <i>Materiales Metálicos de Construcción</i>, Alaman, A., Serv. de Publicaciones R.O.P. E.T.S.I. Caminos, Madrid, 1990.</li> <li>• <i>Materiales Bituminosos</i>, Fernández, M., Serv. de Publicaciones R.O.P. E.T.S.I. Caminos, Madrid, 1990.</li> </ul> <p><b>Teaching organization:</b> Teaching is divided into theoretical lectures, and practical lectures with application of the theory and laboratory sessions. Guided visits to factories, laboratories and worksites related to the course will take place during the term.</p> <p><b>Assessment:</b> Two assessment tests will be provided. Each test is divided in a series of blocks covering different contents, and a minimum grade may be required in each of them. A minimum of 4 out of 10 in each test and an average of 5 out of 10 must be obtained to pass. Students failing on the partial test scheme may take a final exam covering the whole subject in June and September; passing requirements will be the same as in partial tests. In both cases, the full cycle of laboratory sessions must have been accomplished.</p> <p><b>Teacher:</b> Belén González Fonteboa, José Orejón Pajares, Juan I. Vázquez Peña.</p>			
106	T	<p><b>Surveying (A)</b></p> <p><b>Description:</b> Photogrammetrical surveying and cartography. Topography.</p> <p><b>Aims:</b> To acquire the set of essential techniques to obtain measurements, form, plans, established layouts, to find geometries on the terrain or control movements of structures or land works.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. General introduction.</li> <li>2. Topographic instruments.</li> <li>3. Topographical methodologies.</li> <li>4. Mapping.</li> <li>5. Surveying applied to road engineering.</li> <li>6. Geodesy and cartography.</li> <li>7. Astronomy.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Introducción a la Topografía</i>, Ferrer Torío, R. y Piña Patón, B., S. Publicaciones E.T.S.I.C.C.P., Santander, 1991.</li> <li>• <i>Instrumentos Topográficos</i>, Ferrer Torío, R. y Piña Patón, B., S. Publicaciones E.T.S.I.C.C.P., Santander, 1991.</li> <li>• <i>Metodologías Topográficas</i>, Ferrer Torío, R. y Piña Patón, B., S. Publicaciones E.T.S.I.C.C.P., Santander, 1991.</li> <li>• <i>Lectura de Mapas</i>, Vázquez Maure, F. y Martín López, J.</li> <li>• <i>Topografía General y Aplicada</i>, Domínguez García-Tejero, F., Editorial Dossat.</li> <li>• <i>Geodesia y Cartografía Matemática</i>, Martín Assin, F.</li> <li>• <i>Topografía</i>, Chueca Pazos, M., Editorial Dossat.</li> <li>• <i>Topografía y Replanteos</i>, Martín Morejón, L., Editorial Romargraf.</li> <li>• <i>Métodos Topográficos</i>, Ojeda Ruiz, J.L.</li> </ul> <p><b>Teaching organization:</b> During 3 hours a week the theoretical lectures are provided and the practical exercises previously set are resolved. In the facilities of the School the students must carry out a series of field and studio practices, in order to achieve a full training in the topic. At the same time they carry out visits to cartographic production centres.</p> <p><b>Assessment:</b> To pass it is necessary to have submitted and to pass the course projects. Two assessment exams are held besides the final exams of June and September. To pass the course it is necessary to obtain a minimum mark in each partial exam, and the course projects and the field and studio practices</p>	9  (6.5)	6	3

		will be taken into account.  <i>Teacher:</i> Antonio López Blanco, Ángel González del Río y José A. Serantes Barbeito			
		<b>Free Configuration</b>	<b>6</b> <b>(4)</b>		

## SECOND YEAR

201	T	<p><b>Calculus II (A)</b></p> <p><i>Description:</i> Ordinary differential equations. Introduction to numeric methods and programming.</p> <p><i>Aims:</i> To know, to understand and to apply the analytical methods that allow for the resolution of Ordinary Differential Equations. To acquire the basic knowledge in the use of computers and FORTRAN programming.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. First order differential equations.</li> <li>2. Higher order differential equations.</li> <li>3. Calculation of variations.</li> <li>4. Systems of differential equations.</li> <li>5. Laplace transform.</li> <li>6. Power series resolution of differential equations.</li> <li>7. Fourier series.</li> <li>8. Computer and FORTRAN programming.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• Edwards C.H., Penney D.E., <i>Ecuaciones Diferenciales Elementales y Problemas con Condiciones en la Frontera</i>. Prentice Hall Hispanoamericana. Méjico 1994.</li> <li>• Kreyszig E., <i>Advanced Engineering Mathematics</i> (7ª edición). Wiley. Nueva York 1993.</li> <li>• Simmons G. F., <i>Ecuaciones Diferenciales. Con Aplicaciones y Notas Históricas</i>(2ª edición). McGraw-Hill. Madrid 1993.</li> <li>• Vellando P., <i>Colección de problemas resueltos de ecuaciones diferenciales</i>. CopyBelén. Santiago 2002</li> <li>• Vellando P., <i>Problemas de ecuaciones diferenciales. Aplicaciones a la ingeniería</i>. CopyBelén. Santiago, 2005</li> <li>• Zill D.G., <i>Ecuaciones Diferenciales con Aplicaciones de Modelado</i>. International Thomson Editores. Méjico 2002.</li> <li>• Ellis T.M.R., <i>FORTRAN 77 Programming. With an Introduction to the FORTRAN 90 Standard</i>. Addison-Wesley. Wokingham 1990.</li> <li>• Nyhoff L., Leestma S., <i>FORTRAN 77 for Engineers and Scientists. With an Introduction to FORTRAN 90</i>. Prentice Hall. Nueva Jersey 1996.</li> </ul> <p><i>Teaching organization:</i> The theoretical lectures are carried out together with the resolving of some examples and practical problems, which have been previously posed. A FORTRAN code should be written as a coursework. This coursework can be elaborated making use of the computer facilities provided by the School.</p> <p><i>Assessment:</i> So as to be able to pass the subject, it is compulsory to have carried out and passed the coursework. Two partial exams will be held, apart from those held in June and September, covering the whole contents of the subject. So as to pass ‘by course’, a minimum mark is required in each of the assessment exams. The marks obtained in the coursework and the submissions set over the whole length of the course will also be taken into account.</p> <p><i>Teacher:</i> Pablo Rguez- Vellando, Ferndez-Carvajal.</p>	12  (9)	6	6
202	T	<p><b>Structures I (A)</b></p> <p><i>Description:</i> Materials resistance. Structures analysis.</p> <p><i>Aims:</i> To develop the elemental analysis of structures, studying the most usual typologies in Civil Engineering. To understand how the characteristics of the</p>	12  (9)	6	6



		<p>structures influence its behaviour.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Basic concepts.</li> <li>2. Reactions and interior forces in isostatic structures.</li> <li>3. Relations of tensional equilibrium in elastic solids.</li> <li>4. Relations between movements and strain.</li> <li>5. Relations tensions/strains. Constitutive equations.</li> <li>6. Bar elements subjected to axle force and flecion.</li> <li>7. Bar elements subjected to uniform tension.</li> <li>8. Bar elements subjected to sharp forces.</li> <li>9. Calculation of movements in bar structures.</li> <li>10. Hyperstatic girders.</li> <li>11. Flat structures of rigid joints. Elemental porticos.</li> <li>12. Plane orthogonal grillage</li> <li>13. Structures formed by curved bars. Elemental arches.</li> <li>14. Lines of influence.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Análisis lineal y no lineal de estructuras de barras</i>, Hernández Ibáñez, S., E.T.S.I. Caminos, Canales y Puertos, Universidad de La Coruña.</li> <li>• <i>Teoría de las estructuras</i>, Timoshenko, S. P., Young, D. H., Ed. Urmo, Bilbao, 1981</li> <li>• <i>Structures</i>, Schodek, Daniel L., Prentice-Hall, New Jersey, 1980</li> <li>• <i>Elementary Structural Analysis</i>, 4th ed., Utku, S., Norris, C. H., Wilbur, J. B., McGraw Hill, New Jersey, 1991</li> <li>• <i>Razón y ser de los tipos estructurales</i>, Torroja, E, C.S.I.C, Instituto Eduardo Torroja, Madrid, 1984</li> <li>• <i>Elasticidad</i> 2a. ed., Ortiz Berrocal, L.; U.P.M. E.T.S.I. Industriales, Madrid, 1985</li> </ul> <p><i>Teaching organization:</i> Four hours per week lessons, two theoretical and two practical ones. Where problems given before are resolved. Most of these problems belong to exams previously given, which allows the student to know his or her level of knowledge of the subject.</p> <p><i>Assessment:</i> The assessment is based on two partial exams, and also the June and September final exams.</p> <p><i>Lecturer en charge:</i> Juan Carlos Perezzan Pardo, José Antonio González Meijide</p>			
203	T	<p><b>Metric and Descriptive Geometry (A)</b></p> <p><i>Description:</i> Metric geometry. Descriptive geometry.</p> <p><i>Aims:</i> To know, to understand and to apply the methods which Descriptive and Metric Geometries give in order to solve geometrical problems and the intersection of surfaces by graphic methods.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Metric geometry.</li> <li>2. Projective geometry.</li> <li>3. Review of descriptive geography.</li> <li>4. Study of surfaces.</li> <li>5. Representation of surfaces.</li> <li>6. Theorems on intersection of quadrics.</li> <li>7. Figures of revolution.</li> <li>8. Developable and buckled adjusted surfaces.</li> <li>9. Surfaces of difficult representation.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Geometría Métrica</i>, Pedro Puig Adám; Ed. Nuevas Gráficas, 2 tomos.</li> <li>• <i>Apuntes de Geometría Métrica</i>, Luciano Olabarrieta.</li> <li>• <i>Problemas de Geometría Métrica</i>, Luciano Olabarrieta.</li> <li>• <i>Geometría Descriptiva Superior y Aplicada</i>, F. Izquierdo Asensi; Editorial Dossat.</li> <li>• <i>Geometría Descriptiva Tomos I y II</i>, Taibo; Editorial Tebar Flores.</li> <li>• <i>Geometría Constructiva y sus aplicaciones</i>, Editorial Labor.</li> </ul> <p><i>Teaching organization:</i> This is an annual subject, 6 CC developed in two lessons of one hour per week in a theoretical and also theoretical-practical way.</p> <p><i>Assessment:</i> To pass ‘by course’: An average of two partial exams and one</p>	6  (4.5)	3	3

		<p>monographic coursework, together with the average of the course practices (the partial exams and the coursework only will be taken into account if their marks are equal or above 3.5 out of 10. In any other case, the students must make up for this doing the corresponding part in the June final examination). September examination: The whole contents.</p> <p><i>Teacher:</i> Jesús María Urrutia y de Lambardi.</p>			
204	T	<p><b>Hydraulics and Hydrology I (A)</b></p> <p><i>Description:</i> Fluid mechanics. Hydraulics. Surface area and subterranean hydrology.</p> <p><i>Aims:</i> To show the basis of fluid mechanics and the fundamental equations that rule the behaviour of fluids in conductions, including technological aspects of the calculation of the flow in pipes and in open channel. At the same time, the basic concepts of qualitative hydrology are introduced.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction to the subject.</li> <li>2. Mechanic characteristics of fluids.</li> <li>3. Hydrostatics: Basic equations.</li> <li>4. Hydrostatics: Calculation of balances and thrusts.</li> <li>5. Movement of fluids in conduits. Basic equations.</li> <li>6. Dimensional analysis.</li> <li>7. Introduction to the idea of boundary layer.</li> <li>8. Study of permanent movement in pipelines.</li> <li>9. Turbomachines.</li> <li>10. Non-permanent movement in pipelines.</li> <li>11. Introduction to the study of movement in free sheets.</li> <li>12. Permanent and uniform movement in canals.</li> <li>13. Specific energy.</li> <li>14. Hydraulic jump. Dissipation of energy.</li> <li>15. Gradually varied open channel flow.</li> <li>16. Rapidly varied movement. Transitions.</li> <li>17. Rapidly varied movement. Outlets and spillways.</li> <li>18. Physical models.</li> <li>19. Introduction to hydrology.</li> <li>20. Precipitation.</li> <li>21. Evaporation, transpiration and interception.</li> <li>22. Infiltration and soil humidity.</li> <li>23. Surface runoff. Analysis of capacity.</li> <li>24. Hydrograph associated to a precipitation.</li> <li>25. Floods in rivers.</li> <li>26. Subterranean hydrology. Basic concepts.</li> <li>27. Subterranean hydrology. Equations and methods.</li> <li>28. Uptake hydraulics.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Mecánica de Fluidos</i>, Shames, I., Mc. Graw-Hill, Bogotá, 1995.</li> <li>• <i>Hydraulics in Civil Engineering</i>, Chadwick, A. y Morfett, J., Harper Collins, London, 1986.</li> <li>• <i>Mecánica de los fluidos</i>, Streeter, V.L., Mc. Graw-Hill, New York, 1958.</li> <li>• <i>Open Channel Flow</i>, Chow, V.T., Mc. Graw-Hill, New York, 1959.</li> </ul> <p><i>Teaching organization:</i> The teaching activity is based on three hours per week sessions, where theoretical aspects together with the resolution of some previously posed exercises are carried out. The students have to do also some coursework making use of the Hydraulics Laboratory of the School.</p> <p><i>Assessment:</i> To pass the subject it is necessary to have done correctly the laboratory coursework. The assessment is based on two partial exams besides the final exams of June and September. To pass the course it is necessary to obtain a mark of 5 out of 10 at each partial exam, or at any of the final ones. The passed partials are kept till September.</p> <p><i>Teacher:</i> Jerónimo Puertas Agudo y Ricardo Juncosa Rivera</p>	9 (6.5)	6	3
205	T	<p><b>Geology and Introduction to Geotechnical Engineering (A)</b></p> <p><i>Description:</i> Geology applied to public works. Soil mechanics. Rock</p>	12 (9)	6	6

		<p>mechanics.</p> <p><i>Aims:</i> To introduce the student to key concepts of geology and elemental geotechnics through the methodological and practical analysis of problems of interest for the Civil Engineer.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction to geology.</li> <li>2. Earth origin and evolutions.</li> <li>3. Earth structure and characterization.</li> <li>4. II</li> <li>5. Mineralogy</li> <li>6. Igneous rocks.</li> <li>7. Sedimentary rocks.</li> <li>8. Metamorphic rocks.</li> <li>9. Tectonics.</li> <li>10. Geomorphology.</li> <li>11. The soil.</li> <li>12. Soil classification and description.</li> <li>13. Hydrogeology of soils and rocks.</li> <li>14. The effective stress principle.</li> <li>15. The flow net.</li> <li>16. The zone no saturated of the soil.</li> <li>17. Geology of Spain.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Ciencias de La Tierra</i>, Tarbuck y Lutgens; Prentice Hall, Madrid, 1999.</li> <li>• <i>Geografía Física</i>, Strahler, A.N.; Omega, 1977.</li> <li>• <i>Geología Estructural. Introducción a las técnicas geométricas</i>, Ragan, D.M.; Omega, Barcelona.</li> <li>• <i>Understanding Earth</i> Press y Siever; W.H.Freeman and Company, New York.</li> <li>• <i>Geología de España</i>, Meléndez, I. Editorial Rueda S.L.; 2004.</li> <li>• <i>Geotecnia y Cimientos I y II</i>, Jiménez Salas, J.A.; Justo, J.L.; Rueda, Madrid, 1975 y 1981.</li> <li>• <i>Principles of Geotechnical Engineering</i>, Das, B.M.; Brooks/Cole, 2002.</li> <li>• <i>Ingeniería Geológica</i>, González Vallejo, L.I. et al.; Prentice Hall, 2002.</li> <li>• <i>An introduction to Geotechnical Engineering</i>, Holtz, R.D. y Kovacs, W.D.; Prentice-Hall, 1981.</li> </ul> <p><i>Teaching organization:</i> Lectures (4 hours each week) including theoretical concepts and problems. In addition, a laboratory coursework and a field trip is included as a main part of the course.</p> <p><i>Assessment:</i> In order to pass the course it is mandatory to perform and pass with sufficiency the practicum program. Two nonabsolving partial examinations (apart from the ordinary June and September final examinations) will be held. It is necessary to reach a minimum mark in order to avoid the final examinations. In the mark will be considered the eventual reports and coursework requested by the lecturers.</p> <p><i>Teacher:</i> Jordi Delgado Martín, Francisco Padilla Benitez.</p>			
206	T	<p><b>Differential Geometry ©<sub>1</sub></b></p> <p><i>Description:</i> Tensor algebra. Differential geometry. Field theory.</p> <p><i>Aims:</i> To learn the tools which Classical Differential Geometry and Field Theory place at the disposal of the engineer.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction to curves.</li> <li>2. Local theory of buckled curves.</li> <li>3. Introduction to surfaces.</li> <li>4. Metrics on a surface.</li> <li>5. Extrinsic geometry of surfaces.</li> <li>6. Introduction to the theory of fields.</li> <li>7. Integral theorems.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Lectures on Classical Differential Geometry</i>, Struik, D.J., Dover Publications, Inc., New York, 1988(reimpresión).</li> </ul>	6  (4.5)	3	3

		<ul style="list-style-type: none"> <li>• <i>Geometría diferencial</i>, López de la Rica, A. y de la Villa, A., I.C.A.I., Madrid, 1986.</li> <li>• <i>Geometría diferencial de curvas y superficies</i> do Carmo, M.P., Alianza Universidad Textos, Madrid, 1990.</li> <li>• <i>Vectors and Tensors in Engineering and Physics</i>, Danielson, D.A., Addison—Wesley, New York, 1992.</li> <li>• <i>Vector Analysis for Engineers and Scientists</i>, Lewis, P.E. y Ward, J.P., Addison—Wesley, New York, 1992.</li> <li>• <i>Advanced Engineering Mathematics</i>, Kreyszig, E., John Wiley &amp; Sons, New York, 1988.</li> </ul> <p><i>Teaching organization:</i> Once the theory of each theme has been developed, the students set out -by groups- the correspondent practical exercises.</p> <p><i>Assessment:</i> To demonstrate efficiency in the subject, it is required to pass any of the final exams, which take place in three annual sessions: February June and September.</p> <p><i>Teacher:</i> Ramón Martul Álvarez de Neyra.</p>			
207	T	<p><b>General Economics Applied to Public Works ©<sub>1</sub></b></p> <p><i>Description:</i> General economics. Applied economics to public works. Valuing. (4.5)</p> <p><i>Aims:</i> To analyse the working mechanisms of an economy from a global point of view. To make an introduction to the generality of economic problems in the companies and the different existing approaches for their resolution. To study the Economy of construction as an economic activity within the General Economy.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Basic concepts. Supply and demand.</li> <li>2. The company and production.</li> <li>3. Theory of distribution.</li> <li>4. The macroeconomic analysis.</li> <li>5. Financing of economic activity.</li> <li>6. Sectorial and macroeconomic policies.</li> <li>7. The construction sector.</li> <li>8. Public works demand.</li> <li>9. Project of investment in public works.</li> <li>10. Administrative and institutional aspects.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Economía, Teoría y Política</i>, Mochon Morcillo F. (Última edición). Ed. McGraw-Hill. Madrid.</li> <li>• <i>Introducción a la Economía Positiva</i>, Lipsey R. G. (1996). Ed. Vicens-Vives. Barcelona.</li> <li>• <i>Economía</i>, Wonnacott R. J., Wonnacott P. (1992). Ed. McGraw-Hill. Madrid.</li> <li>• <i>Curso de Economía</i>, González Paz, J. (1988). Ed. Debate. Tomos I, II y III. Madrid.</li> <li>• <i>Economía</i>, Samuelson P. y Nordhaus W.D. (2002). Ed. McGraw-Hill. Madrid.</li> <li>• <i>Economía</i>, Fischer S., Dornbusch R., y Schmalense. (1993). Ed. McGraw-Hill. Madrid.</li> </ul> <p><i>Teaching organization:</i> Throughout the course lectures on theory are given and practical cases are commented on. The students, distributed in teams, must do a coursework.</p> <p><i>Assessment:</i> Final exams will be held in February and September, and the coursework carried out in teams throughout the academic year will be taken into account.</p> <p><i>Teacher:</i> Alejandro M. Vasallo Rapela.</p>	6  (4.5)	4.5	1.5
208	T	<p><b>Mechanics ©<sub>2</sub></b></p> <p><i>Description:</i> Mechanics. (4.5)</p> <p><i>Aims:</i> Training students in engineering mechanics so as to solve some engineering applications related to mechanics in Civil Engineering.</p> <p><i>Syllabus:</i></p>	6  (4.5)	3	3

		<ol style="list-style-type: none"> <li>1. Vectorial analysis.</li> <li>2. Kinematics.</li> <li>3. Mass geometry.</li> <li>4. Dynamics.</li> <li>5. Statics.</li> <li>6. Analytical mechanics.</li> <li>7. Oscillations.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• Goicolea Ruigómez, J.M. <i>Mecánica</i>. Universidad Politécnica de Madrid, 1995</li> <li>• Beer, Ferdinand P. <i>Mecánica vectorial para ingenieros: estática y dinámica</i> McGraw-Hill 2004</li> <li>• Meriam, J.L. <i>Mecánica para ingenieros: estática y dinámica</i> Reverté 1999</li> <li>• Shames, Irving H. <i>Mecánica para ingenieros: estática y dinámica</i>. Prentice Hall Iberia 1998</li> <li>• Marion, Jerry B. <i>Dinámica clásica de las partículas y sistemas</i>. Reverté D.L. 1990</li> <li>• Bastero de Eleizalde, José M<sup>a</sup>. <i>Curso de mecánica</i>. Ediciones Universidad de Navarra 1991</li> <li>• Goldstein, Herbert. <i>Mecánica clásica</i>. Reverté D.L. 1994</li> <li>• Vázquez, Manuel. <i>Mecánica para ingenieros</i>. Noela 1988</li> <li>• Das, Braja M. <i>Mecánica para ingenieros : Estática y Dinámica</i>. Limusa [1999]</li> </ul> <p><b>Teaching organization:</b> As a general rule, during the course, the lecturer will dedicate two hours per week to theory and two hours per week to solving problems.</p> <p><b>Assessment:</b> The evaluation is carried out through the final exams in June and September.</p> <p><b>Teacher:</b> Mar Toledano Prados.</p>			
209	T	<p><b>Transports and Land Use ©<sub>2</sub></b></p> <p><b>Description:</b> Transport. Engineering and territory.</p> <p><b>Aims:</b> To introduce the student to the territorial processes which cause the transport infrastructures which an engineer plans and builds. To bring the students closer to a view of land as a historic construction, based on cartography, showing the role of transport in its formation and transformation.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Transport and territory. Concept.</li> <li>2. The process of urbanization of land.</li> <li>3. Cartography as an instrument of analysis of the territory.</li> <li>4. The elements of analysis of a land structure.</li> <li>5. Transport and land in the past.</li> <li>6. Urbanization of medieval land.</li> <li>7. Urban structure of the medieval city.</li> <li>8. The new forms of intervention in the city from the 16<sup>th</sup> century.</li> <li>9. The new forms of intervention in the city from the 17<sup>th</sup> century.</li> <li>10. Transport and land in the 18<sup>th</sup> century.</li> <li>11. The city of the illustration, baroque and military urbanism.</li> <li>12. Transport and land in the 19<sup>th</sup> century.</li> <li>13. The city of the 19<sup>th</sup> century. The suburb and interior reform.</li> <li>14. Transport in the 20<sup>th</sup> century.</li> <li>15. Forms of urban growth in the 20<sup>th</sup> century.</li> <li>16. Territorial systems and transport networks.</li> <li>17. Infrastructures of transport and the environment.</li> <li>18. Infrastructures of transport and regional development.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• “El Territorio y los Caminos en Galicia. Planos Históricos de la Red Viaria”, Carlos Nárdiz Ortiz. Ed. Xunta de Galicia. Colegio de Ingenieros de Caminos, C. y P. 1992.</li> <li>• “Resumen Histórico del Urbanismo en España”, García Bellido y otros. Instituto de Estudios de la Administración Local. Madrid 1968.</li> <li>• “Territorio y Ciudad en la España de la Ilustración”, Carlos Sambricio, Ed. MOPT. Madrid 1991.</li> <li>• “Diseño de la Ciudad-5. El arte y la Ciudad Contemporánea”, Leonardo Benevolo. Ed. Gustavo Gili. Barcelona 1981.</li> <li>• “La Coruña. Metrópolis Regional”, Andrés Precado. Fundación Caixa Galicia. 1990.</li> <li>• “Plan Director de Infraestructuras 1993-2007”, Publicaciones del MOPTMA. 1994.</li> </ul> <p><b>Teaching organization:</b> The course has a theoretical component derived from</p>	6  (4.5)	4.5	1.5

		<p>the program explanation and a practical component derived from the coursework the students do in a continuous and individualized way, in order to study a specific territorial strip, the influence which the transport infrastructures had had on its process of formation and transformation. It is considered in this sense that, due to its compulsory character, this course constitutes the base for other subjects in later courses, in which the relations between the infrastructures and the land can be studied in depth.</p> <p><i>Assessment:</i> The assessment is based on an practical exercise developed in phases in an individualized way, and a final exam.</p> <p><i>Teacher:</i> Carlos Nárdiz Ortiz y Juan Creus Andrade</p>			
		<b>Free Configuration</b>	<b>6</b> <b>(4)</b>		

## SECOND CYCLE

### THIRD YEAR

301	T	<p><b>Numerical Calculus (A)</b></p> <p><i>Description:</i> Numerical calculus. Numericals applied to engineering.</p> <p><i>Aims:</i> To know, to understand and to apply the main numerical methods for solving the most common problems in Civil Engineering.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. General concepts.</li> <li>2. Number and algorithm.</li> <li>3. Errors.</li> <li>4. Iterative solution of non-linear equations.</li> <li>5. Basis of matrix calculus. Computation of eigenvalues.</li> <li>6. Linear systems of equations.</li> <li>7. Approximation and interpolation.</li> <li>8. Numerical integration and derivation.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Cálculo Numérico. Métodos. Aplicaciones</i>, Carnahan, B., Luther, H.A. y Wilkes, J.O., Editorial Rueda, Madrid, 1979.</li> <li>• <i>A First Course in Numerical Analysis</i>, Ralston, A. y Rabinowitz, P., Mc Graw-Hill, New York, 1978.</li> <li>• <i>Introduction to Numerical Analysis</i>, Hildebrand, F.B., Mc Graw-Hill, New York, 1974.</li> <li>• <i>Introduction to Numerical Analysis</i>, Stoer, J. y Burlisch, R., Springer-Verlag, New York, 1980.</li> <li>• <i>Analysis of Numerical Methods</i>, Isaacson, E. y Keller, H.B., John Wiley &amp; Sons, New York, 1966.</li> <li>• <i>Numerical Recipes. The Art of Scientific Computing</i>, Press, W.H., Flannery B.P., Teukolsky, S.A. y Vetterling, W.T., Cambridge University Press, Cambridge, 1986.</li> </ul> <p><i>Teaching organization:</i> The theoretical and practical lectures extend for four hours per week, developing the fundamental theory and solving the exercises and practical problems previously set. In the Centre of Calculus of the School, the students must solve a set of application problems by devising several FORTRAN codes as a part of the work of the course.</p> <p><i>Assessment:</i> In order to pass the course, it is required to submit the programme course work. Two assessment examinations, in February and June, and two final exams, in June and September, are held. In order to pass the course, it is required to obtain a minimum mark in each partial exam. The mark of the programme coursework and the exercises proposed during the course are taken into account.</p> <p><i>Teacher:</i> Fermín Navarrina Martínez, Ignasi Colominas Ezponda, Gonzalo Mosqueira Martínez</p>	12  (8.5)	6	6
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302	D	<p><b>Statistics (A)</b></p> <p><i>Description:</i> Theory of probability. Inference. Statistics. Contrast of hypothesis. Bayesian theory of decision. Stochastic processes. Experiments.</p> <p><i>Aims:</i> The subject tries, through the comprehension of the randomness of most of the physical, social and economic phenomena, to show the student the right way to take decisions in the presence of uncertainty.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Theory of probability.</li> <li>2. Statistic inference.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Probability, Statistics and Decision for Civil Engineers</i>, Benjamin, J.R. y C. Cornell, McGraw-Hill, New York, 1970</li> <li>• <i>Probabilidad y Estadística</i>, Canavos, G.C., Mc Graw-Hill, México, 1987</li> <li>• <i>Probabilidad y Aplicaciones Estadísticas</i>, Meyer, P.L., Addison-Wesley Iberoamericana, México, 1992</li> <li>• <i>Probability, Random Variables and Stochastic Processes</i>, Papoulis, A., McGraw-Hill Kagakusha, Tokyo, 1965</li> <li>• <i>Estadística. Modelos y Métodos</i>, 2 Vol. Peña, D. Alianza Universal, Madrid, 1986</li> <li>• <i>Introducción a la Teoría de la Probabilidad y a la Inferencia Estadística</i>, Durand, A.I. y S.L. Ipiña Ed. Rueda, Madrid, 1994</li> <li>• <i>Engineering Statistics</i>, Hogg, R.V. y J. Ledolter, Mc Millan, New York, 1987</li> </ul> <p><i>Teaching organization:</i> The teaching activity is three hours per week. No differences will be made between the theoretical and practical sessions. Some exercises will be proposed periodically and later solved during the lecturing hours.</p> <p><i>Assessment:</i> The assessment is based on two partial exams. Each partial exam includes all the contents given from the beginning of the course until the time of the exam. During the exam it is allowed to consult any material needed: books, notes, etc. To pass the course it is required to get an average mark in each partial exam, the submitted course work is also taken into account.</p> <p><i>Teacher:</i> Manuel Casteleiro Maldonado y Xavier Domínguez Pérez</p>	9 (6.5)	4.5	4.5
303	T	<p><b>Structures II (A)</b></p> <p><i>Description:</i> Structures analysis.</p> <p><i>Aims:</i> To complete the formation about traditional methods of calculation in bar structures. Analysis of bar structures in second order theory. Introduction to the bending of slabs and to the study of spherical and revolution shells. Matrix methods for calculation of bar structures.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Principles of virtual works.</li> <li>2. Energy theorems.</li> <li>3. Hyperstatic structures of articulated joints.</li> <li>4. Elastic instability of bar structures.</li> <li>5. Bending of isotropic slabs in elastic linear range.</li> <li>6. Buckling of thin slabs.</li> <li>7. Theory of shells in elastic and linear range.</li> <li>8. Introduction to buckling in shells.</li> <li>9. Matrix analysis of structures. Method of equilibrium.</li> <li>10. Description of a program of matrix calculation of structures.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Análisis lineal y no lineal de estructuras de barras</i>, S. Hernández, Temas 1, 2, 3, 4 y 9.</li> <li>• <i>Mechanics of Elastic Structures</i>, Oden, J.T., McGraw-Hill, Temas 1 al 3.</li> <li>• <i>Theory of Elastic Stability</i>, Timoshenko y Gere, McGraw-Hill, Temas 4 al 9.</li> <li>• <i>Steel Structures</i>, William MacGuire, Prentice-Hall. Temas 4 al 9.</li> <li>• <i>Teoría de placas y láminas</i>, Timoshenko, Voinowsky, Krieger, Urmo. Temas 6 al 9.</li> <li>• <i>Background to Buckling</i>, H.G. Allen, P.S. Bulbon. Tema 8.</li> <li>• <i>Backing of Bars, Plates and Shells</i>, Brush, Almroth. Tema 8.</li> <li>• <i>Cálculo matricial de estructuras</i>, Saez-Benito Espada, J.M., F.E.I.N. Temas 10 al 14.</li> </ul>	12 (8.5)	6	6



		<ul style="list-style-type: none"> <li>• <i>Métodos matriciales para cálculo de estructuras</i>, Livesley, R.K., Blume. Temas 10 al 14.</li> <li>• <i>Ejemplos resueltos de cálculo matricial de estructuras con el programa SAP90</i>, J.A.Jurado; S.Hernández, Tórculo, 1997,Tema 9</li> </ul> <p><i>Teaching organization:</i> For 4 hours a week theoretical lectures and exercises are carried out. The students resolve structural models in the Laboratory of Calculation of Structures by means of computer programs.</p> <p><i>Assessment:</i> There will be two partial exams, and the final exams of June and September.</p> <p><i>Teacher:</i> José Ángel Jurado Albarracín, Arturo N. Fontán Pérez y Alejandro Mosquera Martínez.</p>			
304	T	<p><b>Geotechnical Engineering II (A)</b></p> <p><i>Description:</i> Geotechnique. Cementations. Soil and rock dynamics.</p> <p><i>Aims:</i> The main aim of this subject is to supply the students with the necessary knowledge and information about Soil Mechanics, introducing the laws and key rules for geotechnical calculus.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Stresses in a soil.</li> <li>3. Compressibility of soil.</li> <li>4. Shear strength of soil.</li> <li>5. Stresses in elastic soil.</li> <li>6. Plasticity of soil.</li> <li>7. Lateral earth pressure.</li> <li>8. Slope stability.</li> <li>9. Soil bearing capacity for shallow foundations.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Geotecnia y Cimientos I y II</i>, J.A. Jiménez Salas y otros, Editorial Rueda, Madrid, 1975 y 1981.</li> <li>• <i>Mecánica de Suelos</i>, T.W. Lambe y R.V. Whitman, Limusa, 1991.</li> <li>• <i>The Mechanics of soils</i>, J.H. Atkinson y P.L. Bransby, Mc Graw-Hill, 1978.</li> <li>• <i>Elastic solutions for soil and rock mechanics</i>, H.G. Poulos y E.H. Davis, Centre for geotechnical reseach, University of Sidney,1991.</li> <li>• <i>Soil Mechanics in Engineering Practice</i>, K. Terzaghi y R.B. Peck, John Wiley, 1967.</li> <li>• <i>Introduction to geotechnical Engineering</i>, R.D. Holtz y W.D. Kovacs, Prentice Hall, 1981.</li> </ul> <p><i>Teaching organization:</i> Theoretical and practical lectures. Compulsory laboratory exercises.</p> <p><i>Assessment:</i> Two partial examinations will be made during the course besides the final examinations in June and September. In order to pass the subject the students should attend the laboratory lectures and submit a report about them.</p> <p><i>Teacher:</i> Luis Medina Rodríguez y Jorge Molinero Huguet.</p>	12 (8.5)	6	6
305	T	<p><b>Continuum Mechanics ©<sub>1</sub></b></p> <p><i>Description:</i> Continuum mechanics. Constructive equations. Elasticity and viscous elasticity. Plasticity and viscous plasticity.</p> <p><i>Aims:</i> To introduce the student to Continuum Mechanics from both a general and particular point of view in subjects like Structures, Hydraulics and Hydrology and Geotechnical Engineering. Elastic, elastic-plastic, viscoelastic and fluid mechanics models.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Stress equations.</li> <li>2. Kinematics of a continuous medium.</li> </ol>	7.5 (6)	4.5	3



		<p>3. Constitutive equations of a continuous medium.  4. Linear elasticity constitutive equations.  5. Two-dimensional linear elasticity.  6. Plastic behaviour of a continuous medium.  7. Elastic-plastic behaviour of cross sections (I). Axial forces and pure bending.  8. Elastic-plastic behaviour of cross sections (II). Simple and compound Bending.  9. Plastic analysis of beams and porticos.  10. Viscoelastic behaviour of a continuous medium.  11. Fluid mechanics.</p> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>A First Course in Continuum Mechanics</i>, Y.C. Fung, Prentice Hall. Temas 1, 2, 3, 10, 11.</li> <li>• <i>Foundation of Solid Mechanics</i>, Y.C. Fung, Prentice Hall. Temas 1, 2, 3, 4, 5, 10, 11.</li> <li>• <i>Introduction to the mechanics of a continuous medium</i>, L.E. Malvern, Prentice Hall. Temas 1, 2, 3, 4, 5, 10, 11.</li> <li>• <i>Curso de Elasticidad</i>, Samartín, Bellisco. Temas 1, 2, 4, 5, 6.</li> <li>• <i>Teoría de la elasticidad</i> Timoshenko y Goodier, Urmo. Temas 1, 2, 4, 5, 6.</li> <li>• <i>Nociones de cálculo plástico</i>, C. Benito, Revista de Obras Públicas. Temas 7, 8, 9.</li> </ul> <p><b>Teaching organization:</b> Three hours of theoretical lectures and two practical hours are given per week, where both suggested exercises and exam exercises from previous years are solved.</p> <p><b>Assessment:</b> By means of a final exam, in June and September.</p> <p><b>Teacher:</b> Alejandro Mosquera Martínez.</p>			
306	D	<p><b>Calculus III ©<sub>1</sub></b></p> <p><b>Description:</b> Variation calculus. Differential equations in partial derivatives. (4)</p> <p><b>Aims:</b> To know and to apply the main results of the classical examples in Mathematical Physics, and to know the main analytical techniques for the resolution of Partial Differential Equations.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Statement of problems in mathematical physics.</li> <li>3. First-order partial differential equations.</li> <li>4. Method of separation of variables.</li> <li>5. Non-homogeneous problems.</li> <li>6. Green's functions for boundary value problems.</li> <li>7. Integral transforms.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Elementary Applied Partial Differential Equations</i>, Haberman R.; Prentice Hall, 1987.</li> <li>• <i>Curso de Ecuaciones Diferenciales en Derivadas Parciales</i>, Weinberger H.F.; Ed. Reverté, 1988.</li> <li>• <i>Partial Differential Equations of Applied Mathematics</i>, Zauderer E.; John Wiley &amp; Sons, 1988.</li> <li>• <i>Problemas de la Física Matemática (vols. 1 y 2)</i>, Budak B.M., Samarski A.D. y Tijonov A.N.; Mc Graw Hill, 1993</li> <li>• <i>Advanced Engineering Mathematics (7th ed.)</i>, Kreyszig E.; John Wiley &amp; Sons, 1993.</li> <li>• <i>Primer Curso de Ecuaciones Diferenciales en Derivadas Parciales</i>, Peral Alonso I.; Addison-Wesley/Universidad Autónoma de Madrid, 1995.</li> <li>• <i>Methods of Mathematical Physics (vol. II)</i>, Courant R. y Hilbert D.; John Wiley &amp; Sons, 1962.</li> </ul> <p><b>Teaching organization:</b> The theoretical and practical lectures extent for four hours per week, developing the fundamental theory and solving the exercises and practical problems previously set.</p> <p><b>Assessment:</b> An partial examination in February and two final exams, in June and September, are held. In order to pass the course at the end of the first semester, it is required to obtain a minimum grade in the partial exam and to submit the exercises set during the course.</p> <p><b>Teacher:</b> Ignasi Colominas Ezponda.</p>	6	3	3

307	T	<p><b>Materials Science ©<sub>2</sub></b></p> <p><i>Description:</i> Science of materials. Fracture mechanics.</p> <p><i>Aims:</i> Conceptual. The student who studies this subject must learn:</p> <ul style="list-style-type: none"> <li>-The relation between the materials structure, the mechanic properties and the possible treatments and techniques of microstructural modification.</li> <li>-The main properties of the engineering materials.</li> <li>- The methods, procedures and equipment to the mechanical characterization of the materials.</li> <li>- The different criteria from breakage according to the fracture mechanics.</li> </ul> <p><i>Syllabus:</i></p> <p>Part I: Science of materials.</p> <ol style="list-style-type: none"> <li>1. Introduction to the science and engineering of the materials</li> <li>2. Atomic structure and I connect.</li> <li>3. Crystalline structures and geometries.</li> <li>4. Crystalline defects and imperfections.</li> <li>5. Diaphragms of phases and termic treatments.</li> <li>6. Mechanical properties.</li> <li>7. Elastic deformation.</li> <li>8. Crystalline solid plasticity.</li> <li>9. Mechanisms of hardening.</li> <li>10. Materials used in engineering and its properties.</li> </ol> <p>Part II. Fracture mechanic.</p> <ol style="list-style-type: none"> <li>11. Fracture of structures.</li> <li>12. Energetic criterion of fracture.</li> <li>13. Tensional criterion of fracture.</li> <li>14. Propagation of fatigue fissures.</li> </ol> <p><i>Bibliography:</i></p> <p>Science and engineering of materials.</p> <ul style="list-style-type: none"> <li>• <i>Introducción a la Ciencia e Ingeniería de los materiales.</i> W.D. Callister, Ed. Reverté, S.A., (1996).</li> <li>• <i>Mechanical behaviour of materials.</i> N.E. Dowling. Ed. Prentice-Hall International, (1993)</li> <li>• <i>Ciencia e ingeniería de los materiales.</i> D.R. Askeland. Ed. Paraninfo- Thomson Learning, (2001).</li> <li>• <i>Introducción a la ciencia de materiales para ingenieros.</i> J.F. Shakelford, Ed. Prentice-Hall, (1998).</li> <li>• <i>Ciencia e ingeniería de materiales.</i> W.F. Smith, Ed. McGraw-Hill, (2004).</li> </ul> <p>Fracture mechanic.</p> <ul style="list-style-type: none"> <li>• <i>Mecánica de la fractura.</i> J.L. Arana, J.J. González. Ed. Universidad del País Vasco, (2002)</li> <li>• <i>Fractura de materiales.</i> M. Anglada, J. Alcal. Ed. UPC, Barcelona, (2002)</li> <li>• <i>Mecánica de la fractura.</i> A.M. Meizoso. J.M.M. Esnaola. Ed. Universidad de Navarra, (1999)</li> <li>• <i>Mecánica de la fractura.</i> J.L. González V. Ed. Noriega, (1998)</li> </ul> <p><i>Teaching organization:</i> The methodology didactic used is expositive. The practical exercises are made in the laboratory of Sciences of Materials. The laboratory classes are nor obligatory. The seminars are dedicated to the interactive work between the teacher and the student.</p> <p><i>Assessment:</i> The evaluation of the student depends on the examination (80%), the seminars (15%) and the practical exercises (5%). Exams are in two parts. First part with short questions, and the second part with the most important aspects of the subject. For the resolution of the problems the students can use programmable calculators.</p> <p><i>Teacher:</i> Mar Toledanos Prados.</p>	7.5  (6)	4.5	3
308	D	<p><b>Hydraulics and Hydrology II ©<sub>2</sub></b></p> <p><i>Description:</i> Fluid mechanics. Fluvial hydraulics. Subterranean hydrology: transportation of contaminants. Exploitation of aquifers.</p> <p><i>Aims:</i> The subject gives the students the fundamentals and the methods of calculation on Hydraulics not only on the surface but also under the ground.</p>	6  (4)	3	3

		<p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. The components of hydrologic cycle.</li> <li>3. Hydrologic balances.</li> <li>4. Surface run-off and hydrographs.</li> <li>5. Analysis of extreme events. Flood and dry periods.</li> <li>6. Subterranean hydrology.</li> <li>7. Hydrous resources: evaluation and uses of water.</li> <li>8. Quality and contamination of waters.</li> <li>9. Applications of hydrology in civil engineering.</li> <li>10. Hydrology and environment.</li> <li>11. Hydrology in Galicia and Spain.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Hidrología Subterránea</i>, Custodio, E., Llamas, M.R., Editorial Omega, S.A., 1983</li> <li>• <i>Hydrology for engineers</i>, Linsley, Kohler y Paulhus, McGraw-Hill, Inc., 1982</li> <li>• <i>Engineering Hydrology</i>, Subramanya K., Tata McGraw-Hill, 1994</li> <li>• <i>Hidrología Aplicada</i>, Ven Te Chow, D.R. Maidment y L.W. Mays, McGraw-Hill, 1994</li> </ul> <p><b>Teaching organization:</b> The teaching activity is based on four hours per week of theoretical lectures together with the resolution of some practical exercises which are previously proposed to be evaluated after their resolution and submission.</p> <p><b>Assessment:</b> The final mark of the subject will be obtained from the marks obtained in the exams of the Subject</p> <p><b>Teacher:</b> Javier Samper Calvete y Ricardo Juncosa Rivera.</p>			
		<p><b>Optional</b></p> <p><b>Free Configuration</b></p>	<p><b>6</b></p> <p><b>(4)</b></p> <p><b>6</b></p> <p><b>(4)</b></p>		
<b>FOURTH YEAR</b>					
401	T	<p><b>Reinforced and Prestressed Concrete I (A)</b></p> <p><b>Description:</b> Reinforced concrete. Prestressed concrete.</p> <p><b>Aims:</b> To teach fundamentals of the behaviour of reinforced and prestressed concrete structures, and to provide a basis for the student to design, build and maintain this type of structures.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Reinforced and prestressed concrete structures project.</li> <li>3. Structural elements.</li> <li>4. Structural concrete construction.</li> <li>5. Summary.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Hormigón Armado y Pretensado I</i>, Murcia, J., Aguado, A. y Mari, A.R., Edicions UPC, Barcelona, 1993.</li> <li>• <i>Hormigón Armado</i>. 14ª Edición basada en la EHE, ajustada al Código Modelo y al Eurocódigo. Jiménez, P., García, A. y Morán, F., Gustavo Gili, Barcelona, 2000.</li> <li>• <i>EHE Instrucción de Hormigón Estructural</i>, Ministerio de Fomento, Madrid, 1999.</li> <li>• <i>Design of Prestressed Concrete Structures</i>, Lin, T.Y., Burns, N.H., John Wiley &amp; Sons, New York, 1981.</li> <li>• <i>Hormigón armado y pretensado. Ejercicios</i>, Mari, A.R., Aguado, A., Agulló, L., Martínez, F., Cobo, D., Edicions UPC, Colección Politext, Barcelona, 1999.</li> <li>• <i>Proyecto y cálculo de estructuras de hormigón</i>, Tomos I y II, Calavera, J., Intemac, 1999.</li> <li>• <i>La EHE explicada por sus autores</i>. Coordinador de la obra: Garrido, A., Leynfor, Madrid, 1999.</li> <li>• <i>Prestress concrete analysis and design</i>, Naaman, A., McGraw-Hill, 1982.</li> <li>• <i>Prestress concrete basics</i>, Collins y Mitchel, Canadian PCI, 1987.</li> <li>• <i>Manual de Aplicación de la EHE. Materiales-ejecución-control (Comentado)</i>, Garrido, A., Leynfor, Madrid, 1999.</li> </ul>	<p><b>9</b></p> <p><b>(7)</b></p>	4.5	4.5

		<p><i>Teaching organization:</i> There are three lectures per week, dedicated to theory and practice. In addition, construction site visits will be organised, and laboratory practices will be developed in the Construction Engineering Laboratory and the CITEEC.</p> <p><i>Assessment:</i> During the course, some practices are set for the students, which are necessary to pass the subject, besides laboratory practices. Two assessment exams are held during the course. If any of the partial exams is not passed, the final examination will take place in June and September. Once the examination is passed, practices will be taken into account for the final marks</p> <p><i>Teacher:</i> Fernando Martínez Abella, Cristina Vázquez Herrero y Belén González Fonteboa</p>			
402	T	<p><b>Environmental Engineering (A)</b></p> <p><i>Description:</i> Sanitary engineering. Ecology elements. Environmental impact. Evolution and correction.</p> <p><i>Aims:</i> To know, understand and apply technology to solve problems related with urban solid wastes, atmosphere and sound pollution and the relationships between quality and water contamination as well as designing the water supply and sewage systems of a population.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Sanitary and environmental engineering: origin and evolution.</li> <li>2. Environmental problems. Environmental management.</li> <li>3. Ecology and microbiology. Basic concepts.</li> <li>4. Public health. Human demography.</li> <li>5. Dirt and urban wastes.</li> <li>6. Solid urban wastes. Collection and transport.</li> <li>7. Solid urban wastes. Treatment and/or removal.</li> <li>8. Atmosphere and sound pollution.</li> <li>9. Water management.</li> <li>10. Natural water.</li> <li>11. Water pollution. Waste waters.</li> <li>12. Water quality. Its control.</li> <li>13. Water quality in rivers. Self- purification.</li> <li>14. Pollution of lakes. Reservoirs and aquifers.</li> <li>15. Dumping urban wastes in the sea.</li> <li>16. Collecting, pipes and pumps for water supply.</li> <li>17. Storage and measuring of water.</li> <li>18. Treatment of water supply: free decantation.</li> <li>19. Coagulation- flocculation.</li> <li>20. Decanting. Special settling tanks.</li> <li>21. Filtering.</li> <li>22. Rapid filtering.</li> <li>23. Disinfecting, chlorinating, ozonation.</li> <li>24. Special treatments.</li> <li>25. Water distribution networks.</li> <li>26. Drains network.</li> <li>27. Purifying wastewater.</li> <li>28. Pretreatment.</li> <li>29. Primary treatments.</li> <li>30. Biological treatments. Basics.</li> <li>31. Bacterial beds.</li> <li>32. Active sludges.</li> <li>33. Treatment and removal of sludges. Thickening.</li> <li>34. Stabilization of sludges.</li> <li>35. Dehydration and removal of sludges.</li> <li>36. Purifying of A.R.U of small communities.</li> <li>37. Natural purifying. Re- use of water.</li> <li>38. Environmental impact.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Manual técnico del agua</i>, DEGREMONT, Cuarta edición, 1979.</li> <li>• <i>Depuración de aguas residuales</i>, Hernández, A., Colegio I.C.C.P., Madrid, 1990.</li> <li>• <i>Abastecimiento y distribución de aguas</i>, Hernández, A., Colegio I.C.C.P., Madrid, 1990.</li> <li>• <i>Ingeniería sanitaria: tratamiento, evacuación y reutilización de aguas</i>, Metcalf-Eddy, McGraw-Hill; 1995.</li> <li>• <i>Abastecimiento de agua y alcantarillado</i>, Steel, E.W. y McGhee, T., Gustavo Gili, Barcelona, 1981.</li> </ul>	9  (7)	4.5	4.5

		<ul style="list-style-type: none"> <li>• <i>Introducción a la Ingeniería Sanitaria y Ambiental</i>, Tejero, I., Suárez, J., E.T.S. de Ing. de Caminos de La Coruña y Santander, 1995.</li> </ul> <p><i>Teaching organization:</i> For 3 hours a week theoretical lectures are imparted and the problems proposed in the lectures are solved. Laboratory practices and computer practices will be carried out. The student will do a course project.</p> <p><i>Assessment:</i> In order to pass the course it is necessary that the coursework and the laboratory classes have been completed. Two partial examinations will be set besides the final exams of June and September. To pass the course the two assessment examinations must be passed (8 marks) and the marks of the coursework and practice work are taken into account (2 marks).</p> <p><i>Teacher:</i> Joaquín Suárez López, Alfredo Jácome Burgos y Estrella Rodríguez Justo</p>			
403	T	<p><b>Harbours and Coasts (A)</b></p> <p><i>Description:</i> Littoral and Maritime dynamics. Harbours and Coasts. Maritime works.</p> <p><i>Aims:</i> To acquire the basic knowledge and capacities which deal with the area of Harbours and Coasts. To understand the dynamic phenomena involved in the oceanic, atmospheric and coastal environment. To give response to the problems that the shore, harbours and coasts pose in Civil Engineering. To know the actions of engineering upon the shore, as well as their impact in the environment, especially on the sea shore.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction to the engineering of harbours and coasts.</li> <li>2. General atmospheric-oceanic dynamic. Maritime climate.</li> <li>3. Coastal environment and littoral geomorphology.</li> <li>4. Waves. Description, generation and propagation.</li> <li>5. Long period waves. Tides and currents.</li> <li>6. Littoral processes. The behaviour of beaches.</li> <li>7. Bays and estuaries.</li> <li>8. Harbours. Functions. Users. Typologies.</li> <li>9. Coastal engineering structures.</li> <li>10. Coastal protection, planification and management.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Coastal Engineering</i>, HORIKAWA, K., 1978. Univ. of Tokyo Press.</li> <li>• <i>Coastal Meteorology</i>, HSU, S.A., 1988. Academic Press.</li> <li>• <i>Coastal, Estuarial and Harbour Engineers' Reference Book</i>, ABBOTT, M.B. &amp; PRICE, W.A., 1994. E &amp; FN Spon.</li> <li>• <i>Meteorología Dinámica. Clima de las costas españolas</i>, ACINAS, J. R., 1997, Universidade da Coruña. Tórculo A.G., A Coruña.</li> <li>• <i>Port Engineering. 2 Vols</i>, Bruun P., Gulf Publishing Co, 1973-1989.</li> <li>• <i>Recomendaciones para obras marítimas</i>, FOMENTO, 1990, .... Puertos del Estado.</li> <li>• <i>Shore Protection Manual</i>, CERC, Coastal Engineering Research Center, 1984, U.S. Army Corps of Engrs. U. S. Govt. Printing Office, 2 Vols.</li> <li>• <i>Water wave Mechanics for Engineers and Scientists</i>. DEAN, R.G. &amp; DALRYPLE, R.A., 1984. World Scientific, Advanced Series in Ocean Engineering.</li> <li>• <i>Wind waves. Their generation and propagation on the ocean surface</i>, KINSMAN, B., 1965. Prentice Hall.</li> </ul> <p><i>Teaching organization:</i> During three hours a week lectures will be made up of theory and will outline and solve examples aiming to achieve the participation of the student. Different applications will be proposed which will form the course work.</p> <p><i>Assessment:</i> It is recommended that coursework be carried out. There will be two partial exams during the year apart from the final ones in July and September. To pass 'by course' it is required to obtain a minimum mark in each exam, moreover, the coursework mark will be taken into account.</p> <p><i>Teacher:</i> Juan R. Acinas García y Ricardo Babío Arcay.</p>	9 (7)	4.5	4.5

404	T	<p><b>Roads and Airports ©<sub>1</sub></b></p> <p><i>Description:</i> Traffic engineering. Roads and airports.</p> <p><i>Aims:</i> To know the problem areas of design and construction of the different elements of a road. The subject can be considered to be focused on the following blocks: 1) design of a cross section and analysis of the capacity of a road, 2) project and construction of explanations, 3) the lay -out of the road, and 4) the planning of flexible road surfaces and their construction processes.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Traffic engineering.</li> <li>2. Lay-out of roads.</li> <li>3. Earthworks and drainage.</li> <li>4. Road surfaces.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Normativa vigente del Ministerio de Fomento</i>, Instrucción de carreteras, PG-3/75 modificado, Instrucción de drenaje 5.2.I.C.</li> <li>• <i>Colección de libros: Tráfico, explanaciones y drenajes, trazado de carreteras, y firmes</i>, Kraemer C., E.T.S. de Ingenieros de Caminos de Madrid.</li> <li>• <i>Ingeniería de Tráfico</i>. Antonio Valdés</li> <li>• <i>Manual de Capacidad de Carreteras</i>. Asociación técnica de carreteras. Comité español de la A.I.P.C.R.</li> <li>• <i>Control de calidad en obras de carreteras</i>, Ignacio Morilla Abad</li> <li>• Revistas <i>CEDEX</i> y <i>Carreteras</i>.</li> </ul> <p><i>Teaching organization:</i> In the five hours per week of lectures the theoretical aspects are given and the practical exercises are set in the themes being dealt with. In parallel, the laboratory practical lectures are held referring to the fundamental tests explained in the theoretical lectures.</p> <p><i>Assessment:</i> The evaluation of the subject is carried out by means of a final exam, and the participation in the lectures is taken into account as well as the submitting of the practical exercises.</p> <p><i>Teacher:</i> Ignacio Pérez Pérez</p>	7.5  (5.5)	4.5	3
405	T	<p><b>Electrical Engineering ©<sub>2</sub></b></p> <p><i>Description:</i> Electricity. Electrical engineering. Energetic systems.</p> <p><i>Aims:</i> To know the principles of electricity and electromagnetism with the aim of comprehending the functioning of the electric machines and applying them to the calculation of the aforementioned.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Basic concepts.</li> <li>2. Laws of electromagnetism.</li> <li>3. Stationary electric current.</li> <li>4. Circuits with continuous current.</li> <li>5. Magneto- statics.</li> <li>6. Alternating currents.</li> <li>7. Networks with alternating current.</li> <li>8. Triphasic systems</li> <li>9. Static electric machines. Transformers.</li> <li>10. Electric machine dynamics.</li> <li>11. Normative and classification of installations.</li> <li>12. Generation of electric energy.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Electromagnetismo y Circuitos eléctricos</i>, Fraile, J., Servicio de publicaciones, UPM, Madrid, 1990.</li> <li>• <i>Máquinas Eléctricas</i>, Fraile, J., Servicio de publicaciones, UPM, Madrid, 1992.</li> <li>• <i>Introducción a las Instalaciones Eléctricas</i>, Fraile, J., Servicio de publicaciones, CICCIP, Madrid, 1993.</li> <li>• <i>Teoría de Circuitos. Fundamentos</i>, Ras, E., Marcombo, S.A., 1988.</li> <li>• <i>Teoría y Problemas de Circuitos Eléctricos</i>, Edminister, J.A., Mc Graw-Hill, New York, 1990.</li> <li>• <i>Transformadores de Potencia, de Medida y de Protección</i>, Ras, E., Marcombo, S.A.</li> </ul>	6  (4)	3	3

		<ul style="list-style-type: none"> <li>1994.</li> <li><i>Maquinas Eléctricas</i>, Sanjurjo, R., Mc Graw-Hill, Madrid, 1990.</li> <li><i>Manual de Ingeniería Eléctrica</i>, Fink, D.G. y Wayne, H., Mc Graw-Hill, México, 1996.</li> </ul> <p><i>Teaching organization:</i> 4 hours per week theoretical lectures are held and practical exercises previously given are resolved.</p> <p><i>Assessment:</i> To pass a final exam held in February or another in September. In addition, the lecture participation is evaluated continuously and taken into account.</p> <p><i>Teacher:</i> Luis Montenegro Pérez.</p>			
406	T	<p><b>Steel Structures and Combined Construction ©<sub>2</sub></b></p> <p><i>Description:</i> Steel Structures. Combined constructions.</p> <p><i>Aims:</i> To know and to understand the resistant behaviour of steel and combined structures, applying it to the dimensioning and design of those, following the existing regulations.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. General concepts.</li> <li>2. Limit state (L. S).</li> <li>3. Enveloping surroundings, loads and classification of actions.</li> <li>4. Straight pieces in flexion, traction/ compression and torsion.</li> <li>5. Lateral buckling and web buckling.</li> <li>6. Means of linking.</li> <li>7. Definition of combined structure: concrete and steel.</li> <li>8. Normal loads (axil and flector) and transversals (sheating, torsion and connection)</li> <li>9. Methods of calculation, predimensioned and connections.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>Hernández, S. (1996); <i>Diseño de Estructuras de Acero</i>. ETSICCP de la Universidade da Coruña.</li> <li>Doria, J., Hernández, S., Romera, L. (1997); <i>Ejercicios de Estructuras de Acero</i>. ETSICCP de la UDC.</li> <li>Quintero, M., y Cudós, V. (1987); <i>Estructuras Metálicas. Piezas Flectadas, Comprimidas y Uniones</i> (3 tomos). Escuela de la Edificación.</li> <li>Marco, J. (1997); <i>Fundamentos para el cálculo y diseño de estructura metálica de acero laminado</i>. Mc Graw-Hill.</li> <li>Marco, J. (2000); <i>Curso básico de cálculo y diseño de estructuras metálicas en ordenador</i>. Mc Graw-Hill.</li> <li>Martínez, R. (1999). <i>Ejercicios de Estructuras Metálicas conforme al EC3</i>. ETSICCP de Madrid.</li> <li>ITEA; Programa europeo de formación en cálculo y diseño de la construcción en acero.</li> <li>Rodríguez, R. (1997). <i>Manual de Estructuras Metálicas de Edificios Urbanos</i>. CEDEX.</li> <li>Rodríguez, R. (1999). <i>Prontuario de Estructuras Metálicas</i>. CEDEX.</li> <li><i>Manual de Cálculo de Estructuras Metálicas</i>. Pronturio de ENSIDESA.</li> <li>Martínez, J. (1990); <i>Apuntes de Estructuras Mixtas</i>. ETSICCP de Madrid.</li> <li>Martínez, J. Y Ortiz Herrera J. (1978); <i>Construcción Mixta Hormigón Acero</i>. Ed. Rueda.</li> <li>NBE-EA-95. Estructuras de Acero en Edificación. Ministerio de Fomento.</li> <li>NBE-AE-88. Acciones en Edificación. Ministerio de Fomento.</li> <li>NCSR-02. Norma de Construcción Sismorresistente. Ministerio de Fomento.</li> <li>Eurocódigo 1. Acciones sobre las Estructuras y Bases de Cálculo. AENOR.</li> <li>Eurocódigo 3. Proyecto de Estructuras de Acero. AENOR.</li> <li>Eurocódigo 4. Proyecto de Estructuras Mixtas de Hormigón y Acero. AENOR.</li> </ul> <p><i>Teaching organization:</i> For 5 hours a week theoretical lectures are held and exercises are resolved based on the theoretical aspects explained. The students must carry out a coursework consisting of the study of a real structure.</p> <p><i>Assessment:</i> Final exams are held in June and September.</p> <p><i>Teacher:</i> Arturo Norberto Fontán Pérez y Luis Esteban Romera Rodríguez</p>	7.5  (5.5)	3	4.5
407	T	<p><b>Hydraulic Works ©<sub>1</sub></b></p>	6	3	3



		<p><i>Description:</i> Hydraulic works. Dams. Utilization of hydroelectric.</p> <p><i>Aims:</i> To know the necessity of regulation and lamination of the contributions, the project and dimensioning of hydraulic conductions. To make an introduction to the study of dams and hydroelectric exploitation, irrigated land and fluvial works. To introduce themes of fluvial hydraulics and the restoration of fluvial beds.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Hydraulic resources.</li> <li>2. Pipes.</li> <li>3. Introduction to the study of dams.</li> <li>4. Hydroelectric exploitation.</li> <li>5. Fluvial hydraulics and restoration of rivers.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Centrales Hidroeléctricas</i>, Ediciones Paraninfo.</li> <li>• <i>Apuntes de Obras Hidráulicas</i>, E.T.S. Ing. Caminos. Madrid.</li> <li>• <i>Selecting Hydraulic Reaction Turbines</i>. U.S. Bureau of Reclamation.</li> <li>• <i>Tratado Básico de Presas</i>, E. Vallarino. Colegio de Ingenieros de Caminos.</li> <li>• <i>Salto de Agua y Presas de Embalse</i>, Gómez Navarro.</li> <li>• <i>Transitorios y oscilaciones en sistemas hidráulicos a presión</i>, Abreu et al., U.P. Valencia.</li> <li>• <i>Aprovechamientos Hidroeléctricos</i>, E. Vallarino, L. Cueva,. Colegio de Ingenieros de Caminos.</li> <li>• <i>Hidráulica Fluvial</i>, J.P. Martín Vida, UPC, Politext.</li> <li>• <i>HEC-RAS Manual de Hidráulica</i>.</li> <li>• <i>Restauración de Ríos y Riberas</i>, M. González del Tanago. ETS I. Montes, UPM.</li> </ul> <p><i>Teaching organization:</i> 4 hours a week of theoretical lectures are held where practical exercises previously posed are also solved.</p> <p><i>Assessment:</i> To pass it is necessary to do the coursework. Final exams are held in June and September.</p> <p><i>Teacher: Profesores:</i> Jerónimo Puertas Agudo, Rodrigo del Hoyo Fernández-Gago, Enrique Peña González.</p>	(4)		
		<p><b>Optional</b></p> <p><b>Free Configuration</b></p>	<p>18</p> <p>(12)</p> <p>12</p> <p>(8)</p>		
<b>FIFTH YEAR</b>					
501	T	<p>Organisation and Management of Projects and Works (A)</p> <p><i>Description:</i> Engineering projects. Procedures and construction machines. Management of projects and works.</p> <p><i>Aims:</i> To understand that the project planner, abided by multiple conditions (of technical, legal and property character), faced with a certain problem must provide with valid alternatives, choose the optimum one and bring it to fruition, foreseeing the problems of its construction. To know the technical, economic and legal framework, as well as the construction and planning processes of the works.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Preliminary aspects to the drawing up of a project.</li> <li>2. Drawing up the project. Its processing.</li> <li>3. The project planners field.</li> <li>4. Aspects prior to the contracting of works.</li> <li>5. Development of the contract of works.</li> <li>6. The construction industry</li> <li>7. Technical-economiv planning and control of works.</li> <li>8. Installations, assembly and auxiliary aids.</li> <li>9. Proceedings used in digging of earth.</li> </ol>	<p>9</p> <p>(6)</p>	4.5	4.5



		<p>10. Foundation and compacting of the earth.  11. Lifting and transport processes. Aggregates and concrete.  12. Planning of specific works.  13. Ensuring quality in projects and works.</p> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Guía metodológica y práctica de proyectos</i>, Morilla Abad I. ETSICCP, Madrid.</li> <li>• <i>Manual de gestión de las obras de contratación pública</i>, Rubio González A.</li> <li>• <i>Manual de Contratos del Estado</i>, García Ortega P.</li> <li>• <i>La ejecución del contrato de obra pública</i>, Juristo R.</li> <li>• <i>Contratos del Estado: Dirección de obras</i>, Menéndez Gómez E.</li> <li>• <i>Manual del contratista de Obras Públicas</i>, Viader A.</li> <li>• <i>Movimiento de tierras: utilización de la maquinaria. Producciones y casos prácticos. Compactación de materiales y utilización de compactadores</i>, Tiktin J., ETSICCP, Madrid.</li> <li>• <i>Procesamiento de áridos: Instalaciones de hormigonado. Puesta en obra de hormigón</i>, Tiktin J., ETSICCP, Madrid.</li> <li>• <i>Manual de Maquinaria de Construcción</i>. Manuel Diez del Río. Edit: MacGrawGill</li> <li>• <i>Valoración de obras en Ingeniería Civil</i>. Gonzalo de Fuentes Bescós. Univ. Politécnica de Madrid.</li> <li>• <i>Manual de Planificación y Programación para Obras Públicas y Construcción (1 y 2)</i>. José P. Bendicho Joven. Edit: Rueda</li> <li>• <i>Maquinaria y métodos modernos en construcción</i>. Frank Harris. Instituto Politécnico de Wolverhampton. Edit. Bellisco</li> <li>• <i>Contratos de las Administraciones Públicas</i>. BOE</li> </ul> <p><b>Teaching organization:</b> For three hours weekly classes in theory are given and practical exercises resolved. During the course five visits will be carried out to installations of nearby works. Three conferences will be held. At the same time, the students should carry out a course project on a construction topic. Complementary activity: practical exercise trip.</p> <p><b>Assessment:</b> Two partial exams besides the final exams of June and September. To pass the course it is necessary to obtain a minimum mark in each partial exam and to have carried out the practical parts and the course work, these being taken into account in the final marks.</p> <p><b>Teacher:</b> César García Cordobilla y Enrique Maciñeira Alonso.</p>			
502	T	<p><b>Building and Prefabrication ©<sub>2</sub></b></p> <p><b>Description:</b> Building. Prefabrication.</p> <p><b>Aims:</b> Prefabrication: to know prefabricated elements typology, their main design criteria and production processes. Building: design, building and maintenance of buildings through knowledge of structure, detailing, finishes, installations and specific equipment for building construction.</p> <p><b>Syllabus:</b>  A. Prefabrication.  A1. Introduction.  A2. Building prefabrication.  A3. Bridge prefabrication.  A4. Other prefabricated elements.  B. Building.  B1. Introduction and previous works.  B2. Preparation of terrain. Foundation.  B3. Structures.  B4. Building elements.  B5. Installations.</p> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Estructuras de edificación prefabricadas</i>, FIP-ATEP, Madrid, 1996.</li> <li>• <i>Edificación con prefabricados de hormigón</i>, Vaquero, J. et. al., Ieca, 1996.</li> <li>• <i>Manual de ejemplos de Aplicación de la EHE a la Edificación</i>, Ache Geho-Atep, Madrid, 2001</li> <li>• <i>Proyecto y cálculo de estructuras de hormigón</i>, Tomos I y II, Calavera, J., Intemac, Madrid, 1999.</li> <li>• <i>Normas NTE, NBE/EF-96, NBE/CPI-96, NBE/CT-79, NBE/AE-88,...</i></li> <li>• <i>PCI design handbook: precast and prestressed concrete</i>, 5ª edición, PCI, Chicago, 1999.</li> <li>• <i>Prefabrication with Concrete</i>, Bruggeling, A.S.G., Huygue, G.F., Balkema,</li> </ul>	6 (4)	3	3

		<p>Rotterdam, 1991.</p> <ul style="list-style-type: none"> <li>• <i>PCI manual for the design of hollow core slabs</i>, Buettner, D. R. ., Becker, R. J., PCI, Chicago, 1998.</li> <li>• <i>Multi-storey precast concrete framed structures</i> , Elliott. Bâtir , R. Vittone, Lausanne Polytechniques et Universitaires Romandes, Lausanne, 1996.</li> </ul> <p><i>Teaching organization:</i> There are four lectures per week, dedicated to theory and practice. There are also lectures by building designers, and visits to construction sites and prefabrication plants.</p> <p><i>Assessment:</i> There are final examinations in June and September. To pass the subject it is necessary to have passed each part of the subject: building and prefabrication in the final examinations of June or September.</p> <p><i>Teacher:</i> Cristina Vázquez Herrero y Fernando Martínez Abella</p>			
503	T	<p><b>Transport Engineering ©<sub>1</sub></b></p> <p><i>Description:</i> Planning and exploitation. Of transport. Exploitation of ports. Railways.</p> <p><i>Aims:</i> To explain the essential aims of Transport Engineering: Transport functions. Transport modes. Urban transport. Public services management. Transport demand. Transport costs. Transport infrastructures and services funding. Transport logistics.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Transport.</li> <li>2. Historical development of the Spanish transport system.</li> <li>3. Transport modes.</li> <li>4. Metropolitan transport.</li> <li>5. Public transport services management.</li> <li>6. Carriers management.</li> <li>7. Transport demand.</li> <li>8. Costs.</li> <li>9. Infrastructures and services funding.</li> <li>10. Transport logistics.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• Material docente publicado en la página web de la asignatura.</li> <li>• <i>Economía del transporte</i>, de Rus, G., Campos, J. y Nombela, G. Antoni Bosch Ed., Barcelona, 2003</li> <li>• <i>Fundamentals of Transportation Engineering</i>, Fricker, J.D. and Whitford, R.K. Pearson Prentice Hall, New Jersey, 2004</li> <li>• <i>Handbook of Transportation Engineering</i>, Kutz, M. (ed.). McGraw-Hill, New York, 2004</li> <li>• <i>Sistemas de Transporte</i>, Ruiz A., Publicaciones del Colegio de Ingenieros de Caminos, Madrid, 1995</li> <li>• <i>Transportes</i>, Ibeas, A., Díaz, J.M. Servicio de Publicaciones, E.T.S.I.C.C.P. Santander, 1998</li> <li>• <i>Transportes. Un enfoque integral</i>, Izquierdo, R. (ed.). Publicaciones del Colegio de Ingenieros de Caminos, Madrid, 1994</li> </ul> <p><i>Teaching organization:</i> The theoretical lectures are carried out together with the resolving of some examples and practical problems.</p> <p><i>Assessment:</i> A final exam will be held, covering the whole contents of the subject.</p> <p><i>Teacher:</i> Miguel D. Rodríguez Bugarín, Margarita Novales, Alfonso Orro.</p>	6 (6)	3	3
504	D	<p><b>Legislation ©<sub>2</sub></b></p> <p><i>Description:</i> The basics of administrative and legislative territorial law.</p> <p><i>Aims:</i> To know, understand and apply the basic legislation necessary to develop the profession of Civil Engineer.</p> <p><i>Syllabus:</i></p>	3 (2)	2	1

		<p>1. Constitutional and autonomous law. 2. Administrative law (general part). 3. Administrative law (Particular part).</p> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• Apuntes elaborados por el profesor y entregados en clase.</li> <li>• <i>Curso de Derecho Administrativo I</i>, García Enterriá E, Fernández T.R., Ed. Civitas, Madrid, 1992.</li> <li>• <i>Derecho Administrativo I (parte general)</i>, Parada Vázquez R., Ed. Marcial Pons, Madrid, 1993.</li> <li>• <i>Derecho Administrativo (parte especial)</i>, Bermejo Vera J., Ed. Civitas, Madrid, 1994.</li> </ul> <p><i>Teaching organization:</i> Two hours weekly classes in theory are held and previously proposed practical questions are resolved.</p> <p><i>Assessment:</i> To pass it is necessary to carry out the course work. Exams are held at the end of June and September, and the marks of the coursework and practical work submitted are taken into account.</p> <p><i>Teacher:</i> Juan José Bértolo Cadenas.</p>			
505	T	<p><b>Regional and Urban Planning ©<sub>1</sub></b></p> <p><i>Description:</i> Planning of the territory. Urbanism.</p> <p><i>Aims:</i> To introduce the student to the urban and territorial sense of infrastructures which an engineer projects, constructs and plans. To introduce the student to the theories, the techniques and the objectives of Urban Planning and Regional Organization.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Distribution of the region and urbanism. Concept</li> <li>2. The process of urbanization of the region. The formation of the urban system.</li> <li>3. The rural settlements.</li> <li>4. The historic centres.</li> <li>5. The tradition of baroque and militate urbanism.</li> <li>6. The tradition of the techniques of the 19<sup>th</sup> c. The suburbs and interior reform.</li> <li>7. The origins of modern urbanistic thinking.</li> <li>8. The city of modern movement.</li> <li>9. The analysis of the form of urban growth in the current city.</li> <li>10. The analysis of urban roads in the current city.</li> <li>11. The response of urbanistic legislation. The system of planning in Spain.</li> <li>12. Municipal planning. Objectives and contents.</li> <li>13. The process of elaboration of municipal planning.</li> <li>14. Municipal planning in Galicia.</li> <li>15. Metropolitan planning.</li> <li>16. Transport in metropolitan areas.</li> <li>17. Territorial planning.</li> <li>18. The urban system and the planning of the region.</li> <li>19. The infrastructures of transport and of regional development.</li> <li>20. The infrastructures and the environment.</li> <li>21. The distribution of the physical environment.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Atlas Histórico de Ciudades Europeas. Península Ibérica, Centro de Cultura Contemporánea de Barcelona</i>, 1994.</li> <li>• <i>Galicia: Estructura del Territorio y Organización Comarcal</i>, Andrés Precado Ledo. Santiago, 1987.</li> <li>• <i>Planeamiento Urbano en la España Contemporánea (1900-1980)</i>. Fernando de Terán. Alianza Universidad Textos, Madrid, 1982.</li> <li>• <i>Elementos de Ordenación Urbana</i>, Juli Esteban i Noguera. Colegio de Arquitectos de Cataluña. Barcelona, 1981.</li> <li>• <i>Madrid. Región Metropolitana. Estrategia Territorial y Actuaciones</i>, Comunidad de Madrid. Madrid, 1991.</li> <li>• <i>Plan Director de Infraestructuras 1993-2007</i>, Publicaciones del MOPTMA, 1994.</li> </ul> <p><i>Teaching organization:</i> The course has a strong theoretical component derived from the syllabus and a practical component derived from the contrast between the diagnostic of the territorial reality and the possibilities of Urban Planning and Regional Planning. It is considered that in this sense that the subject at practical level be complemented with the subjects in the field: Urbanism II and Urban Services.</p>	6  (4)	3	3

		<p><i>Assessment:</i> The assessment is based on two exercises on urban theory and another on the urban and regional reality, together with a final exam.</p> <p><i>Teacher:</i> Carlos Nárdiz Ortiz y Juan Creus Andrade</p>			
506	T	<p><b>Business Organization and Management ©<sub>1</sub></b></p> <p><i>Description:</i> Business economy. Management of public works companies.</p> <p><i>Aims:</i> It is expected that the student acquires the necessary knowledge from the moment a business is planned until it is working. This general aim is defined in the following points: a) a general idea about the firm and its strategy, b) a basic knowledge about accounting, c) organization, d) legal help, e) the system to be taken into account about staff, production and marketing, f) a follow-up of the financial situation in the firm, g) a financial position and analysis and h) to go into detail about the basic principles of the firm in the building sector.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Business enterprise.</li> <li>2. Business strategy.</li> <li>3. Structure.</li> <li>4. Accounting.</li> <li>5. Analytic accounting.</li> <li>6. Legal system.</li> <li>7. Human factor.</li> <li>8. Production.</li> <li>9. Marketing.</li> <li>10. Quality.</li> <li>11. Management.</li> <li>12. Financial accounting.</li> <li>13. Balance sheet.</li> <li>14. Trade books.</li> <li>15. Collection and payment instruments.</li> <li>16. Current assets.</li> <li>17. Fixed assets.</li> <li>18. Liabilities.</li> <li>19. Income statement.</li> <li>20. Financial analysis.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Organización y Gestión de Empresas</i>, Fernández Garitaonandía A., ETSICCP, A Coruña</li> <li>• <i>Contabilidad para Dirección</i>, Pereira Soler F., Ediciones Universidad de Navarra, S.A., Pamplona</li> <li>• <i>Mementos Prácticos: Sociedades Mercantiles, Fiscal y Social</i>, Ediciones Francis Lefebvre, Madrid</li> <li>• Textos varios de Ediciones Deusto, S.A., Madrid</li> </ul> <p><i>Teaching organization:</i> Theoretical lectures and practical exercises are solved for 4 hours per week.</p> <p><i>Assessment:</i> There are two final examinations: the first one in June and the second one in September.</p> <p><i>Teacher:</i> Antonio Fernández Garitaonandía.</p>	6 (4)	3	3
507	D	<p><b>History of Civil Engineering ©<sub>1</sub></b></p> <p><i>Description:</i> History of civil engineering. Art and esthetics in Civil engineering.</p> <p><i>Aims:</i> To find out about the history of Civil Engineering (public works in particular and constructions in general) so that this historic heritage is justly assessed, to study the process of calculus of the factories and to establish intervention criteria for the Historic Heritage of Public Works.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Civil engineers in the history of Europe.</li> <li>2. History of arched structures.</li> </ol>	3 (2)	2	1

		<p>3. Historic evolution of the road and port infrastructures.  4. The city: Layout and public health networks.  5. The historic heritage of public works.  6. Analysis of stone- works.</p> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Estructuras de fábrica</i>, Jacques Heyman. Instituto Juan Herrera, ETS Arquitectura Madrid, 1995.</li> <li>• <i>A History of Civil Engineering</i>, Hans Straub. Leonard Hill Ltd., Londres, 1952.</li> <li>• <i>Historia de las Obras Públicas en España</i>, Ed. Turner, Colegio de I.C.C.P. Madrid, 1979.</li> <li>• <i>Historia de la Arquitectura</i>, Spiro Kostof. Alianza Forma, Madrid, 1988.</li> <li>• <i>Ingeniería Hidráulica romana</i>, Carlos Fernández Casado. Ed. Turner, Colegio de I.C.C.P. Madrid, 1983.</li> <li>• <i>Ciencia y Tecnología en la España Ilustrada</i>, Antonio Rumeu de Armas. Ed. Turner, Colegio de I.C.C.P. Madrid, 1980.</li> </ul> <p><b>Teaching organization:</b> For two hours per week in the first fourth - monthly period theoretical classes are held, with important visual backup, in accordance with the syllabus of the subject.</p> <p><b>Assessment:</b> The attendance to the lectures will be evaluated. The work carried out during the four- month period and the final exam marks will be taken into account.</p> <p><b>Teacher:</b> Manuel Durán Fuentes.</p>			
510	T	<p><b>Final Project</b></p> <p><b>Description:</b> Elaboration of a final project.</p> <p><b>Aims:</b> The End of Degree Project will consist of the carrying out and presentation, on the part of each student, of an original project which is connected to any of the field s which cover the profession of <i>Ingeniero de Caminos, Canales y Puertos</i>.</p> <p><b>Bibliography:</b> It is handed in a “<i>Procedure for the execution of the End of Degree Project</i>” .</p> <p><b>Teaching organization:</b> The student will hand in to the responsible lecturers his proposal for the End of Degree Project for its approval. The lecturer, in agreement with each student, will establish a calendar of interviews along the course in which he will review the progress of the End of Degree Project.</p> <p><b>Assessment:</b> The project will be presented in the format established in the “<i>Regulation of the End of Degree Project</i>” of the School and the “<i>Procedure for the execution of the End of Degree Project</i>”. The projects will consist of the corresponding Written Papers and Appendices, the Plans, the ‘List of Particular Technical Orders’ and the Budget. The evaluation of each End of Degree Project will be carried out by a examining board nominated to that task and formed by three lecturers of the School. In the public act of evaluation, the student will present his project; during the presentation the examining board will put forward questions which they consider necessary concerning the content of the project. Following this, the Tribunal will retire to deliberate and decide if the project is accepted or should be modified or amplified. Once all the projects presented in the period of presentation are evaluated the qualification of the End of Degree Project will be given.</p> <p><b>Teacher:</b> Pedro Sánchez Tamayo, Alfonso Orro Arcay, Margarita Novales Ordax.</p>	6  (6)	-	6
		<p><b>Optional</b></p> <p><b>Free Configuration</b></p>	<p><b>30</b></p> <p><b>(20)</b></p> <p><b>12</b></p> <p><b>(8)</b></p>		

**NOTE: © Four-month long subjects**

Code	OPTIONAL	Credits (ECTS)	Theory	Practical
<b>SECOND CYCLE</b>				
601	<p><b>Dynamic Analysis of Structures ©<sub>2</sub></b></p> <p><i>Description:</i> Discrete dynamic systems. Continuous dynamic systems. Applications: buildings, dams, interaction. Seismic norms.</p> <p><i>Aims:</i> To train the student in the topic of the most common dynamic loads which affect the structures. During the course they will study systems of one and several degrees of freedom, not only shock absorbing but also non- shock absorbing. Within the dynamic actions they will analyse the method of modal superimposition such as that of the response spectrum.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction and fundamental concepts. Systems with one degree of freedom.</li> <li>2. Response to free vibrations.</li> <li>3. Response to harmonic and periodic forces.</li> <li>4. Response to incremental, pulsating and general forces.</li> <li>5. Earthquakes. General concepts and actions on the structures.</li> <li>6. Seismic response of systems with a degree of freedom.</li> <li>7. Numerical obtaining of the dynamic response. Systems with several degrees of freedom.</li> <li>8. Formulation of problems and equations of movement.</li> <li>9. Natural frequencies and modes of vibration.</li> <li>10. Methods of obtaining of the modes of vibration.</li> <li>11. Formulation of the matrix of shock- Absorption. Types of shock absorption.</li> <li>12. Lineal analysis of systems with several degrees of freedom dynamic loads.</li> <li>13. Seismic response of systems with several degrees of freedom, method of reduction of degrees of freedom.</li> <li>14. Methods of evaluation of the seismic response: integration in time and spectrum of response.</li> <li>15. Systems with mass and distributed electricity. Response to dynamic loads.</li> <li>16. Seismic response of system with mass and distributed elasticity.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• NCSE-02: <i>Norma de Construcción Sismorresistente. Parte general y de edificación.</i> Ministerio de Fomento.</li> <li>• NCSE: <i>Norma de Construcción Sismorresistente. Puentes 2006.</i> Ministerio de Fomento.</li> <li>• EUROCODIGO 8 (1998): <i>Disposiciones para el proyecto de estructuras sismorresistentes.Reglas generales.</i></li> <li>• <i>Acciones sísmicas y requisitos generales de las estructuras. Parte 1.1. AENOR.</i></li> <li>• <i>Dynamic of Structures. Theory and Applications to Earthquake Engineering.</i> Chopra, A.K.Prent. Hall, 1995.</li> <li>• <i>Structural Dynamics. An Introduction to Computer Methods.</i> Craig, Roy R. John Wiley, 1981.</li> <li>• <i>Structural Dynamics. Theory and Computations.</i> Paz, Mario. Chapman, 1997.</li> <li>• <i>The Finite Element Method. Linear Static and Dynamic F.E.A.</i> Hughes, Thomas J.R.; Prentice Hall, 1987.</li> <li>• <i>Mechanical vibrations.</i> Rao, Singiresu S.; 1995</li> <li>• <i>Engineering Vibration.</i> Inman J.; Prentice Hall, 2001</li> <li>• <i>Structural Dynamics for Structural Engineers.</i> Gary C. Hart, Kevin Wong. John Wiley, 2000.</li> <li>• <i>Vibrations of solids and structures under moving loads.</i> Fryba L. Thomas Telford Ltd; 1999</li> <li>• <i>Arquitectura sísmica: Prevención y rehabilitación.</i> A. Bahamón et al. Barcelona, Loft Publications. 2000.</li> <li>• <i>El riesgo sísmico en el diseño de edificios.</i> Barbat A.H. Cuadernos Técnicos 3; 1998</li> <li>• <i>Estructuras sometidas a acciones sísmicas. Cálculo por ordenador.</i> A.H. Barbat, J.M. Canet. CIMNE. 1994.</li> <li>• <i>Estructuras sometidas a acciones dinámicas.</i> Ed. E. Car, F. López y S. Oller. CIMNE. 2000</li> <li>• <i>ITEA.Programa europeo de formación en cálculo y diseño de estructura de acero. Tomo21: Diseño sísmico.</i></li> <li>• <i>Modal Testing: Theory, Practice and application.</i> D.J. Ewins. Research Studies Pr. 2000</li> <li>• <i>Annotated Slide Collection. Earthquake Engineering Research Institute.</i> EERI, 1997</li> <li>• <i>Sap2000. Integrated Software for Structural Analysis and Design. Analysis Reference Manual.</i> CSI, Berkeley,USA 2002.</li> <li>• <i>Three-Dimensional Static and Dynamic Analysis of Structures. A Physical Approach with Emphasis on Earthquake Engineering.</i> Edward L. Wilson. University of California at Berkeley. 2002.</li> </ul> <p><i>Teaching organization:</i> Two hours of theory and two hours of practical lectures are held weekly. Part of these latter will consist of the resolution of structural models in a</p>	6  (4)	3	3

	<p>dynamic regime by means of computer programs.</p> <p><i>Assessment:</i> By means of course work and the end- of- the year exam, in the exam periods of June and September.</p> <p><i>Teacher:</i> Luis Esteban Romera Rodríguez</p>			
602	<p><b>Special Foundations ©<sub>2</sub></b></p> <p><i>Description:</i> Superficial foundations. Floating beams. Baffles. Piles. Concrete shields. Directly submerged cementations. Floating caissons. Deep-water cementations. Expanding clay cementations. Cementations subject to dynamic loads. Underpinning.</p> <p><i>Aims:</i> To complete student education in some aspects of Geotechnical Engineering which have not been dealt with in previous courses.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction to rock mechanics.</li> <li>2. Introduction to the tunnels and underground works.</li> <li>3. Instrumental work.</li> <li>4. Processing, Improvement and reinforcement of the ground.</li> <li>5. Study of special foundations.</li> <li>6. Expansive and collapsible soil foundations.</li> <li>7. Foundation pathologies. Underprops.</li> <li>8. Slopes pathologies.</li> <li>9. Excavation drainage.</li> <li>10. Introduction to soil dynamics.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Geotecnia y Cimientos II y III</i>, J.A. Jiménez Salas y otros, Editorial Rueda, Madrid, 1976 y 1980.</li> <li>• <i>Fundamentos de mecánica del suelo</i> Daniel Graux. Editores técnicos asociados S.A. Barcelona</li> <li>• <i>N.T.E. Cementaciones</i>. Centro de publicaciones del Ministerio de Fomento</li> <li>• <i>Muros pantalla</i>. Schneebeli G. Editores técnicos asociados, Barcelona 1981</li> <li>• <i>Recommandations concernant la conception, le calcul, l'exécution et le controle des tirants d'ancrage</i>. Bureau Securitas. Eyrolles. Paris, 1986</li> <li>• <i>Foundation Analysis and Design</i> Bowles, J.E., McGraw Hill, 5th Edition, 1996</li> <li>• <i>Ingeniería de Cementaciones</i> Peck, Handson, Thornburn, Limusa, S.A. 1982</li> <li>• <i>Manual de taludes</i>. Instituto Geológico y Minero de España</li> <li>• <i>Rock Engineering</i>, J.A. Franklin, M.B. Dusseault, Mc Graw Hill, 1989.</li> <li>• <i>Rock Slope Engineering</i>, E. Hoek, L. Bray, Institution of mining and metallurgy, London, 3rd ed. , 1981</li> </ul> <p><i>Teaching organization:</i> Mainly theoretical lessons and also some practical ones devoted to the resolution of a set of exercises. Course work will be set as group work.</p> <p><i>Assessment:</i> Evaluation will be carried out on the basis of course work and a final exam.</p> <p><i>Teacher:</i> Luis Carmona Iglesias.</p>	6  (4)	3	3
603	<p><b>Control and Regulation of Traffic ©<sub>1</sub></b></p> <p><i>Description:</i> Phases of road conceptual planning. Transport models. Allocation of trips. Continuous circulation. Models of traffic in highways and motorways. Discontinuous traffic. Road networks. Security. Traffic and the environment. Regulation and ordination. Road signs. Traffic lights. Centralized controls.</p> <p><i>Aims:</i> To apply traffic science. To know and apply the methods of regulation of traffic.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Theory of road traffic.</li> <li>2. Intersections with traffic light regulation.</li> <li>3. Traffic lights systems.</li> <li>4. Intersections without traffic light regulation.</li> <li>5. Traffic control in highways.</li> <li>6. Road safety.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Elementos de Ingeniería de Tráfico</i>, Kraemer C., E.T.S. de Ingenieros de Caminos de Madrid.</li> </ul>	6  (4)	3	3



	<ul style="list-style-type: none"> <li>• <i>Ingeniería de Trafico</i>. Antonio Valdés</li> <li>• <i>Manual de Capacidad de Carreteras</i>. Asociación técnica de carreteras. Comité español de la A.I.P.C.R.</li> <li>• <i>Control de tránsito urbano</i>. A. Martínez Márquez.</li> <li>• <i>Modelos de trafico vial</i>. J. G. Gardeta Oliveros.</li> <li>• <i>Traffic Engineering</i>. William R. MacShane y Roger P. Roes.</li> <li>• <i>Revistas CEDEX, Traffic Engineering and Control y Carreteras</i>.</li> <li>• Resúmenes de comunicaciones de diversas jornadas y congresos monográficos.</li> </ul> <p><i>Teaching organization:</i> Theoretical lectures are taught and practical exercises related to the set topics are put forward.</p> <p><i>Assessment:</i> The assessment of the subject is carried out by means of a final exam. The participation in class and the handing in of the set practical exercises is taken into account.</p> <p><i>Teacher:</i> Ignacio Pérez Pérez</p>			
604	<p><b>Structures III ©<sub>1</sub></b></p> <p><i>Description:</i> The method of one-dimensional, two-dimensional and three-dimensional finite elements problems.</p> <p><i>Aims:</i> To inform of the fundamental theories of the methods of discretization of structures in finite elements meshes. To know the problems of civil engineering to which these techniques apply. To know the types of finite elements most commonly used. To learn to use programs of calculation of structures based on finite elements.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. The finite element method.</li> <li>2. Finite elements in two dimensional elasticity.</li> <li>3. Integration in the finite element the formulation.</li> <li>4. Two- dimensional finite elements.</li> <li>5. Three- dimensional finite elements.</li> <li>6. Finite elements in thin slabs.</li> <li>7. Finite elements for thin shells.</li> <li>8. Study of the error in finite elements meshes.</li> <li>9. Adaptable meshes in finite element models.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Cálculo de estructuras mediante el MEF</i>; Romera L.E., Hernández S, Ediciones Torculo, . 2003.</li> <li>• <i>Concepts and applications of finite element analysis</i>; Cook R., Malkus D., Plesha. M., John Wiley,1989.</li> <li>• <i>Cálculo de estructuras por el método de elementos finitos</i>; E. Oñate, CIMNE, 1992.</li> <li>• <i>Introduction to finite elements in engineering</i>; Chandrupatla T.R., Belegundu A. Prentice Hall, 1997.</li> <li>• <i>The finite element method (fifth ed.). Vol 1: The Basis, Vol2: Solid mechanics</i>; Zienkiewicz, O.C., Taylor, R.L, Thomas Telford, 2000.</li> <li>• <i>Linear static finite element analysis. Online training</i>; Anderson, W.J., Automated Analysis Corporation 5CDs, 1994.</li> <li>• <i>The Finite Element Method. Linear Static and Dynamic Finite Element Analysis</i>; T.J. Hughes, Prentice-Hall, 1987.</li> <li>• <i>Finite Element Procedures</i>; K.J. Bathe, Prentice-Hall, 1996.</li> <li>• <i>Introduction to finite element computations</i>; Hinton, E., Owen, D.R.J., Pineridge Press, 1980.</li> <li>• <i>Análisis estático y dinámico de estructuras con el programa COSMOS/M v.2.8</i>; L.E. Romera; S. Hernández, y Mosquera A, Ediciones Torculo, 2003.</li> <li>• <i>Cosmos/m. Finite element analysis system. Vol: I, II, III, y IV</i>; Strutural research and analysis corporation, 2001</li> </ul> <p><i>Teaching organization:</i> For four hours per week theoretical lectures are given and basic exercises are resolved based on the theoretical explanations. Also in the laboratory of Calculation of Structures computer aided work is carried out on structural models to solve these problems by using finite elements programs.</p> <p><i>Assessment:</i> Final exams are held in February and September.</p> <p><i>Teacher:</i> Luis Esteban Romera Rodríguez y Félix Nieto Mouronte</p>	6 (4)	3	3
605	<p><b>Railways ©<sub>1</sub></b></p>	6	3	3



	<p><i>Description:</i> Essential features of railways: structure and mechanics of the track. Geometry and quality of the track. Knots and terminuses. Material and traction. Electrification, signalisation, security, communications and exploitation installations. Commercial and technical exploitation. Organisation and administration of railway activity.</p> <p><i>Aims:</i> To identify the essential features of railway transportation, differentiating them from those in other transportation systems. To identify the track structure; to calculate its geometry and mechanical behaviour; to know and to identify the construction methods, diagnosis and maintenance of the track.</p> <p><i>Syllabus:</i>  I. Introduction.  1. Transport Railways.  II Track structure.  2. General considerations about the track.  3. The rail.  4. Rail junctions. Welded track.  5. Turnouts.  6. Sleepers. Rail fastenings and other track material.  7. Ballast and substructure.  8. Slab track.  9. Brickworks.  III Track geometry and mechanics.  10. Track geometry I.  11. Track geometry II.  12. Track mechanics. Vertical loads.  13. Track mechanics. Track stability and longitudinal forces.  14. Track quality evolution.  IV Track works.  15. Track inspection.  16. Correcting track alignment.  17. Track maintenance and renewal.  18. Planning and construction of new railway lines.</p> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Ferrocarriles</i>, García Díaz-de-Villegas, J.M. Publicaciones de la E.T.S. Ingenieros de Caminos, Santander, 2000.</li> <li>• <i>La Vía del Ferrocarril</i>, Alias, J. y Valdés, A. Editorial Bellisco, Madrid, 1990</li> <li>• <i>Modern Railway Track</i>, Esveld, C., MRT Productions, Duisburg, 1989.</li> <li>• <i>Track geotechnology and substructure management</i>, Seling, E. T. y Waters, J. M. Thomas Telford, Londres, 1994</li> </ul> <p><i>Teaching organization:</i> During 4 hours a week, theory lectures are imparted and numerical examples are solved. Technical visits are organised to visit railway installations in the region, and maintenance and renovation works of tracks.</p> <p><i>Assessment:</i> A final exam is carried out, with a theoretical part and another with practical questions. To pass the course it is required to pass both parts.</p> <p><i>Teacher:</i> Miguel Rodríguez Bugarín y Margarita Novales Ordax</p>	(4)			
606	<p><b>Technical French</b></p> <p><i>Description:</i> French-Spanish equivalent of technical and technological terms related to the science, civil engineering and economics fields. Composing professional letters and technical reports.</p> <p><i>Aims:</i> To facilitate the beginners and “false beginners” in a rapid mastering and efficiency of basic competence in the French language, which will allow them to move easily in common communicative contexts: participate in simple conversations, to understand and be able to use real documents, to write basic texts, deal with professional and semiprofessional everyday situations.</p> <p><i>Syllabus:</i>  1. Linguistic objectives.  2. Grammatical contents.</p> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>L'art de conjuguer: dictionnaire de 12.000 verbes</i>, Hatier, Paris, 1990.</li> </ul>	(4)	6	3	3

	<ul style="list-style-type: none"> <li>• <i>Conjugaison. 350 exercices. 1.000 verbes à conjuguer</i>, Bady, Greaves et Petetin, Hachette FLE, Paris, 1997.</li> <li>• <i>Dictionnaire de la prononciation</i>, Lerond, Larousse, Paris, 1980.</li> <li>• <i>Dictionnaire Moderne français/espagnol-espagnol/français</i>, Larousse, Paris, 1989.</li> <li>• <i>Dictionnaire technique du bâtiment et des travaux publics</i>, Barbier, Eyrolles, Paris, 1988.</li> <li>• <i>Dictionnaire technique français-espagnol</i>, Mink, Herder, Barcelona 1984.</li> <li>• <i>Le français à grande vitesse</i>, Truscott, Mitchell et Tauzin, Hachette FLE, Paris, 1994 [manual de clase]</li> <li>• <i>Francés funcional para universitarios</i>, Sarazá Cruz y Montaigu, Servicio de Publicaciones de la Universidad de Córdoba, 1997.</li> <li>• <i>Grammaire. 350 exercices. Niveau débutant</i>, Bady, Greaves et Petetin, Hachette FLE, Paris, 1996.</li> <li>• <i>Grammaire du français</i>, Delatour et alii, Hachette FLE, Paris, 1991.</li> <li>• <i>Gramática esencial del francés</i>, Fernández Ballón y Monnerie-Goarin, Hachette, Paris, 1987.</li> <li>• Gramática francesa, Cantera y De Vicente Cátedra, Madrid, 1986.</li> <li>• <i>Grammaire progressive du français</i>, Grégoire et Thiévenaz, CLE International, Paris, 1995.</li> <li>• <i>Grammaire vivante du français</i>, Callamand, Larousse, Paris, 1989.</li> <li>• <i>Vocabulaire illustré. 350 exercices. Niveau débutant</i>, Watcyn-Jones, Hachette, Paris, 1992.</li> </ul> <p><i>Teaching organization:</i> All lecture hours are of an eminently practical character. The involvement and active participation of the students in all the set activities is essential.</p> <p><i>Assessment:</i> Along the course there will be 2 written tests of partial assessment and one oral test. To pass 'b y course' it is required to obtain a minimum mark of 5 out of ten in each one. Active participation of the students will be taken into account, not only in lectures but outside them (individual or collective projects).</p> <p><i>Teacher:</i> Mercedes Regueiro Diehl</p>			
607	<p><b>Reinforced and Prestressed Concrete II ©<sub>1</sub></b></p> <p><i>Description:</i> Implementation of reinforced and prestressed concrete. Approach to limit states. Tangential solicitations. New methods of calculating. Structural elements. Special concrete.</p> <p><i>Aims:</i> To deepen the basic knowledge acquired in the subject Reinforced and Prestressed Concrete I, specially in the topics related with design and prestressed concrete.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Design of reinforced and prestressed concrete structures.</li> <li>2. Structural elements.</li> <li>3. Prestressing technology.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Hormigón Armado y Pretensado II</i>, Murcia, J., Aguado, A. y Marí, A.R., Edicions UPC, Barcelona, 1993.</li> <li>• <i>Hormigón Armado</i>. 14ª Edición basada en la EHE, ajustada al Código Modelo y al Eurocódigo. Jiménez, P., García, A. y Morán, F., Gustavo Gili, Barcelona, 2000.</li> <li>• <i>EHE Instrucción de Hormigón Estructural</i>, Ministerio de Fomento, Madrid, 1999.</li> <li>• <i>Hormigón armado y pretensado. Ejercicios</i>, Marí, A.R., Aguado, A., Agulló, L., Martínez, F., Cobo, D., Edicions UPC, Colección Politext, Barcelona, 1999.</li> <li>• <i>Proyecto y cálculo de estructuras de hormigón</i>, Tomos I y II, Calavera, J., Intemac, Madrid, 1999.</li> <li>• <i>La EHE explicada por sus autores</i>. Coordinador de la obra: Garrido, A., Leynfor, Madrid, 1999.</li> <li>• <i>Estructuras de Hormigón Armado</i>, Tomos I a VI, Leonhardt, F., El Ateneo, Buenos Aires, 1984.</li> <li>• <i>Estructuras de Concreto Reforzado</i>, Park, R., Paulay, T., Limusa, México, 1980.</li> <li>• <i>Manual de Aplicación de la EHE. Materiales-ejecución-control (Comentado)</i>, Garrido, A., Leynfor, Madrid, 1999.</li> <li>• <i>Modern prestressed concrete: design principles and construction methods</i>, van Nostrand Reinhold, New York, 1990.</li> <li>• <i>PCI design handbook: precast and prestressed concrete</i>, PCI, Chicago, 1999.</li> </ul> <p><i>Teaching organization:</i> Theoretical and practical lectures are complemented with visits to different construction sites, laboratory practices, and lectures imparted by specialists.</p> <p><i>Assessment:</i> Evaluation consists of a Project of a prestressed or reinforced concrete structure. Possible holding of a teaching seminar on a theme to be determined.</p>	6  (4)	3	3

	<p><i>Teacher:</i> Fernando Martínez Abella, Cristina Vázquez Herrero, Belén González Fonteboa</p>			
608	<p><b>Environmental Impact of Engineering Works ©<sub>1</sub></b></p> <p><i>Description:</i> Ecology of natural systems. The natural environment. Quality factors. Natural resources. Contamination of resources. Urban territorial development problems.</p> <p><i>Aims:</i> To know and understand the functioning of ecosystems, and the environmental factors with the aim of making an inventory of the environment. To study methodologies of evaluation of impacts and its application to studies and evaluations of environmental impact.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Instruments of environmental management.</li> <li>3. Environmental impact.</li> <li>4. Legal framework.</li> <li>5. Process of evaluation of environmental impact.</li> <li>6. Contents of the studies of environmental impact.</li> <li>7. Environmental inventory.</li> <li>8. Evaluation of impacts.</li> <li>9. Methodologies.</li> <li>10. Programmes of vigilance and control.</li> <li>11. Application of methodologies.</li> <li>12. Generation of methodologies.</li> <li>13. Instruments of environmental management.</li> <li>14. Management of residues in civil engineering.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Guía para la elaboración de estudios del medio físico: contenido y metodología</i>, CEOTMA, Ministerio de Obras Públicas, Transporte y Medio Ambiente, MOPTMA, Madrid, 1992.</li> <li>• <i>Guía metodológica para la evaluación de impacto ambiental</i>, Conesa Fdez., V., Mundi Prensa, Madrid, 1995.</li> <li>• <i>Evaluación de impacto ambiental</i>, Gómez Orea, D., Editorial Agrícola Española, S.A., 1994.</li> <li>• <i>Ecología para ingenieros. El impacto ambiental.</i>, Hernández Fdez., S, Colegio de Ingenieros de Caminos, A-Z Ediciones y Publicaciones; 1987.</li> <li>• <i>Guías metodológicas para la elaboración de estudios de impacto ambiental:....diversos títulos.</i>, Monografías de la Secretaría de Estado para las Políticas del Agua y el Medio Ambiente, MOPT, 1989-1994.</li> <li>• <i>Ecología y formación ambiental</i>, Vásquez, G., McGraw-Hill, Méjico, 1993.</li> </ul> <p><i>Teaching organization:</i> For four hours a week lectures in theory are given. The student carries out a course project and different activities of exposition of topics.</p> <p><i>Assessment:</i> To pass it is necessary to have submitted the course project. Additionally, two final theory exams are held in February and September.</p> <p><i>Teacher:</i> Joaquín Suárez López, Alfredo Jácome Burgos, Estrella Rodríguez Justo.</p>	6  (4)	3	3
609	<p><b>Maritime Engineering ©<sub>1</sub></b></p> <p><i>Description:</i> Offshore design and construction. Coasts: the offshore coastal setting and the ordering of resources. Problems of urban territorial development.</p> <p><i>Aims:</i> To fully endow the student with an ability for performing professionally in the field of ports and coasts, by means of knowing and developing studies and real projects. In short, to form specialist professionals in this field.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction to maritime engineering.</li> <li>2. Actions and recommendations to consider in the projects of maritime engineering.</li> <li>3. Field of ports.</li> <li>4. Field of coasts.</li> <li>5. Field of studies of impact on the environment.</li> <li>6. Field of study of physical environment.</li> <li>7. Special projects.</li> </ol>	6  (4)	3	3

	<p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Recomendaciones para Obras Marítimas. ROM, MOPT, Programa ROM</i></li> <li>• <i>Handbook of Coastal and Ocean Engineering</i>, Herbich J. B., Gulf Publishing Co, 1991.</li> <li>• <i>Nearshore Dynamics and Coastal Processes. Theory, Measurement, and Predictive Models</i>, Horikawa K., U. Tokyo Press, 1988.</li> <li>• <i>Coastal Engineering</i>, Silvester R., Elsevier Scientific Pub. Co., 1974.</li> <li>• <i>The applied dynamics of ocean surface waves</i>, Mei C.C., John Wiley &amp; Sons, 1983.</li> <li>• <i>Plan director de infraestructuras 1993-2007</i>, MOPT., S.G. Planificación y Concertación Territorial, 1993.</li> </ul> <p><b>Teaching organization:</b> For 4 hours per week lectures in theory are given, examples are given and resolved by means of the “case method” counting on the participation of the student. The carrying out of a study or a technical project is proposed with the category of coursework.</p> <p><b>Assessment:</b> It is necessary to carry out the exercises proposed during the course. At the end of the course a project or a previously accepted study of maritime engineering will be handed in. The analysis, planning, development and presentation of an adequate solution will be needed in order to pass; the obtaining of alternative solutions and/or original solutions will increase the mark. In these qualification marks, furthermore, the solutions given to the exercises submitted will be taken into account.</p> <p><b>Teacher:</b> Gregorio Iglesias Rodríguez y Ricardo Babío Arcay</p>			
610	<p><b>Nuclear Engineering ©<sub>1</sub></b></p> <p><b>Description:</b> Fusion and fission energy. Nuclear energy and nuclear power. Radioactive isotopes. Detectors. Diffusion theory. Neutron transport. Reactors theory. Control of nuclear reactors. Materials and combustibles. Shielding. Economic and legislative study.</p> <p><b>Aims:</b> 1. To provide a general view about Nuclear Energy oriented towards the needs of a civil engineer. 2. To provide the basic knowledge about nuclear physics, nuclear reactors and nuclear power plants. 3 To put emphasis in the design, construction, performance, dismantling and decommissioning of nuclear power plants and other nuclear facilities. 4. To compare the costs and environmental effects of nuclear energy with other sources of energy. 5. To provide information on radioactive waste management.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Nuclear physics.</li> <li>2. Nuclear power plants.</li> <li>3. Nuclear fuel cycle and nuclear safety.</li> <li>4. Nuclear energy.</li> <li>5. Nuclear waste.</li> <li>6. Applications of radioactive isotopes in civil.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Nuclear Reactor Engineering: Reactor Design Basics</i>. S. Glasston y A. Sesonske (Editor). Chapman &amp; Hall, 1994.</li> <li>• <i>Understanding Radioactive Waste</i>. R.L. Murray y J.A. Powell (Editor). Battelle Press, 1994.</li> <li>• <i>Quinto Plan General de Residuos Radiactivos</i>. Ministerio de Industria y Energía, 1999. (Se puede obtener directamente a través de la página web de ENRESA: <a href="http://www.enresa.es">www.enresa.es</a>).</li> <li>• <i>El almacenamiento geológico profundo de los residuos radiactivos de alta actividad. Principios básicos y tecnología</i>. Julio Astudillo. ENRESA, 2001</li> </ul> <p><b>Teaching organization:</b> The course is taught in the second semester with 4 hours per week of classroom lectures in 2 days. Invited lectures are also scheduled. In addition, technical visits to a nuclear power plant, and nuclear facilities such as El Cabril Power Station for low and intermediate level radioactive waste, uranium mines and the old uranium plant of Andujar (Jaén) are also envisaged.</p> <p><b>Assessment:</b> The course grade is a weighted average of the grades obtained for attendance and participation in classroom lectures, conferences, technical visits, and a final course homework.</p> <p><b>Teacher:</b> Javier Samper Calvete y Luis Montenegro Pérez.</p>	6  (4)	3	3

611	<p><b>Harbour Engineering ©<sub>2</sub></b></p> <p><i>Description:</i> Geopolitics of transport. International maritime commerce. Port system. Berth and mooring works. Construction and ship repair works. Dry dykes. Ordination and dimensioning.</p> <p><i>Aims:</i> Specialised knowledge in the fields of planning, study, projects and building of ports and maritime works. The port and its surrounding area. Relationships between the port and the city. Means of communication.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Vessels, characteristics and dimensions.</li> <li>3. General considerations in the design of port works.</li> <li>4. Design of the maritime area.</li> <li>5. Design of dykes.</li> <li>6. Works for berthing.</li> <li>7. Defence and mooring equipment.</li> <li>8. Dredging.</li> <li>9. Geotechnics in maritime works.</li> <li>10. Navigation aids.</li> <li>11. Planning the land area of the port.</li> <li>12. Fishing ports.</li> <li>13. Marinas.</li> <li>14. Construction. Restoration. Maintenance and repair of port works.</li> <li>15. The port and its surrounding area. Restoration of old port works for urban uses.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Curso de Ingeniería de Puertos y Costas</i>, Rafael del Moral, José M AA Berenguer. Ed. Centro de Estudios y Experimentación de Puertos y Costas 1989.</li> <li>• <i>Design Of Marine Facilities</i>, Show IV Gaythwaite. Ed. Van Nostrand Reinhold (Nueva York).</li> <li>• <i>Port Design, Guidelines and Recomendations</i>. Ed. Tapir Publishers (Noruega).</li> <li>• <i>Port Engineering</i>, Peer Bruun.</li> <li>• <i>Design and Construction of Ports and Marine Structures</i>, A. Quinn. Ed. Mac Graw Hill (Nueva York)</li> <li>• <i>Travaux Maritimes</i>, - 2 tomos. Jean Chapon. Ed. Eyrolles (París).</li> </ul> <p><i>Teaching organization:</i> Theoretical lectures are taught for 4 hours a week and examples are set and solved with the aim of trying to achieve the students' participation. The resolution of practical problems is set with the category of course work.</p> <p><i>Assessment:</i> It is necessary to do the exercises set during the course. The final exams will be held in June and September. In the final marks the adequacy and originality of the solutions given to the examples set during the academic year and the practical exercises handed in are taken into account.</p> <p><i>Teacher:</i> Gregorio Iglesias Rodríguez y Juan Acinas García.</p>	6  (4)	3	3
612	<p><b>Systems Engineering ©<sub>2</sub></b></p> <p><i>Description:</i> Systems engineer. Automatic and controlled. Civil engineering applications.</p>	6  (4)	3	3
613	<p><b>Geotechnical Engineering III ©<sub>2</sub></b></p> <p><i>Description:</i> Subterranean excavations. Tunnels.</p> <p><i>Aims:</i> The main aim of this subject is to supply the students with the necessary knowledge and information about Foundation Engineering: Subsoil exploration, shallow and deep foundation design, and the design of earth retaining structures.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Subsoil exploitation.</li> <li>2. Shallow foundations.</li> <li>3. Deep foundations.</li> <li>4. Earth retaining structures.</li> <li>5. Numerical methods in geotechnical engineering.</li> </ol>	6  (4)	3	3

	<p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Ground Engineer's Reference Book</i>. F. G. (Editor). Butterworks, London, 1987.</li> <li>• <i>Foundation Engineering</i>. A.R. Jumikis. Krieger, Florida, 1987.</li> <li>• <i>Fundamentals of Geotechnical Engineering</i>. B. M. Das. Brooks/Cole, California, 2000.</li> <li>• <i>Sigma/W for finite element stress/deformation analysis: User's Guide</i>. Geo-Slope International, Ltd. Calgary, Alberta. Canada.</li> <li>• <i>Slope/W for slope stability análisis: : User's Guide</i>. Geo-Slope International, Ltd. Calgary, Alberta. Canada.</li> <li>• <i>Geotecnia y Cimientos II y III</i>, J.A. Jiménez Salas y otros, Editorial Rueda, Madrid, 1976 y 1980.</li> <li>• <i>El Metro de Madrid: Un Nuevo Reto</i>. Número especial de la Revista de Obras Públicas (Diciembre de 2000).</li> <li>• <i>Underground Excavations in Rock</i>. E. Hoek &amp; E.T. Brown. Stephen Austin &amp; Sons, UK, 1982.</li> <li>• <i>Curso aplicado de cimentaciones</i>, J.M. Rodríguez Ortiz, J. Serra Gesta, C. Oteo Mazo, Colegio Arquitectos de Madrid, 6 edición, 1995.</li> </ul> <p><b>Teaching organization:</b> Theoretical lectures and the resolution of practical problems. Some practices with commercial finite element codes. During the course students carry out visits to construction works. In order to improve their qualifications, groups of students may voluntarily carry out works about specific points concerning the subject.</p> <p><b>Assessment:</b> Qualification will be obtained through the corresponding examination and the evaluation of the voluntary works.</p> <p><b>Teacher:</b> Jorge Molinero Huguet y Rodrigo del Hoyo Fernández-Gago.</p>			
614	<p><b>Technical English</b></p> <p><b>Description:</b> Spanish-English equivalents of technical and technological terms related to Science, Civil Engineering and Economics. Composing professional letters and technical reports.</p> <p><b>Aims:</b> Students should be able to handle English vocabulary and structures relating to the fields of science, civil engineering and economics, as well as being able to formulate business correspondence and technical reports in English.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Introduction to the numerical language.</li> <li>2. Everyday language.</li> <li>3. Technical vocabulary.</li> <li>4. Business and professional correspondence.</li> <li>5. Memoranda.</li> <li>6. Facsimile.</li> <li>7. Telex.</li> <li>8. Bills of purchase.</li> <li>9. Invoicing.</li> <li>10. International methods of payment.</li> <li>11. International commerce terms (Incoterms)</li> <li>12. Application forms.</li> <li>13. Curriculum vitae.</li> <li>14. The advertisements in a daily paper.</li> <li>15. Technical reports.</li> <li>16. Computing.</li> <li>17. Marketing.</li> <li>18. Use of telephones.</li> <li>19. Phonology.</li> <li>20. Contextual grammar and semantics.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Nuevo diccionario politécnico de las lenguas española e inglesa</i>, Beigbeder F., Ed. Díaz de Santos, S.A.</li> <li>• <i>Technical English for Industry</i>, Yates C.S.J., Fitzpatrick A. Ed. Longman.</li> <li>• <i>Diccionario para Ingenieros</i>, Robb L.A., CECSA.</li> <li>• <i>Diccionario de Arquitectura, Construcción y Obras Públicas</i>, Putman y Carlson, Ed. Paraninfo, S.A.</li> <li>• <i>International Business English (Student book)</i>, Jones L., Alexander R., Cambridge University School.</li> <li>• <i>Writing for Business</i>, Wilson M., Ed. Nelson</li> </ul> <p><b>Teaching organization:</b> Students will attend two hours of class per week, classes will concentrate on the four pillars of language learning: Comprehension; oral skills; translation and interpreting (English – Spanish / Spanish – English).</p>	6  (4)	3	3

	<p><i>Assessment:</i> Attendance at school and the completion of all set work is compulsory to pass the course; in addition, two final exams will be set, in June and September.</p> <p><i>Teacher:</i> Alberto Dopico García</p>			
615	<p><b>Language C</b></p> <p><i>Description:</i> The C programming language.</p>	6 (4)	3	3
616	<p><b>Logistics ©<sub>1</sub></b></p> <p><i>Description:</i> Logistics systems. Management of stock and warehouses. Logistics applied to Transport. Terminals.</p> <p><i>Objetivos:</i> Enterprise logistic knowledge and the industrial one. Dominion of the tools of management of the storage. Relation between logistic and transports. Logistic operators. Design and management of transport terminals.</p> <p><i>Programa:</i></p> <ol style="list-style-type: none"> <li>1. Logistic systems</li> <li>2. Management of existence and warehouses</li> <li>3. Logistic applied to transport</li> <li>4. Terminals</li> </ol> <p><i>Bibliografía:</i></p> <ul style="list-style-type: none"> <li>• “Logística: administración de la cadena de suministros” (5ª ed.). Ballou, R. H. Pearson-Educación. México, 2004.</li> <li>• “Logística del transporte”. Robusté, F. Edicions UPC. Barcelona, 2005.</li> <li>• “Handbook of logistics and supply-chain management” (Handbooks in transport, vol. 2). Brewer, A.M., Button, K.J. y Hensher, D.A. (eds.). Pergamon, 2001.</li> <li>• “Logística integral: la gestión operativa de la empresa”. Anaya Tejero, J. J. ESIC editorial. Madrid, 2000.</li> <li>• “La logística en la empresa: fundamentos y tecnologías de la información y de la comunicación”. Castán, J. M., Cabañero, C. y Nuñez, A. Pirámide. Madrid, 2003.</li> <li>• “A theory of supply chains”. Daganzo, C. F. Springer. Berlín, 2003.</li> <li>• “Centros Integrados de Mercancías”. Colomer, J. Instituto Valenciano de Estudios de Transporte. Valencia, 1995.</li> <li>• “Container terminal planning – A theoretical approach” Watanabe, I. WorldCargo News. Ashtead (Gran Bretaña), 2001.</li> </ul> <p><i>Métodos de enseñanza:</i> During 4 hours to the week theory classes are distributed and practical exercises are solved. It is predicted to make educational visits to logistics installations.</p> <p><i>Métodos de examen:</i> One will offer to the students the option between the evaluation continued by means of the accomplishment of practices and works of course or to make a final examination. The attendance to class will be valued.</p> <p><i>Profesor:</i> Alfonso Orro Arcay</p>	6 (4)	3	3
617	<p><b>Advanced Numerical Methods ©<sub>2</sub></b></p> <p><i>Description:</i> Finite differences. Finite elements. Contour elements. Solving non-linear equation systems.</p> <p><i>Aims:</i> To study in depth the constructive methods which allow solving numerically the most frequent mathematical problems in Civil Engineering.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Integral formulation.</li> <li>3. Basic concepts of mef and applications.</li> <li>4. Interactive methods for systems of lineal equations.</li> <li>5. Solution of non-lineal systems.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• The Finite Element Method: Linear Static and Dynamic Finite Element analysis, T.J.R. Hughes, Dover Publishers, New York, 2000.</li> </ul>	6 (4)	3	3



	<ul style="list-style-type: none"> <li>• <i>The Finite Element Method: I) The Basis, II) Solid Mechanics, III) Fluid Dynamics</i>, O.C. Zienkiewicz y R.L. Taylor, Butterworth-Heinemann, Oxford, 2000</li> <li>• <i>Numerical Solution of Partial Differential Equations by the Finite Element Method</i>, C. Johnson, Cambridge University Press, Cambridge, 1990.</li> <li>• <i>Computational Differential Equations</i>, K. Eriksson, D. Estep, P. Hansbo y C. Johnson, Cambridge University Press, Cambridge, 1996.</li> <li>• <i>Finite Elements and Approximations</i>, O.C. Zienkiewicz y K. Morgan., John Wiley &amp; Sons, New York, 1983.</li> <li>• <i>An Introduction to Continuum Mechanics</i>, M.E. Gurtin, Academic Press, Boston, 1981.</li> <li>• <i>Iterative Methods for Sparse Linear Systems</i>", Y. Saad, Yousef Saad, 2000.</li> <li>• <a href="http://www-users.cs.umn.edu/~saad/books.html">http://www-users.cs.umn.edu/~saad/books.html</a></li> </ul> <p><i>Teaching organization:</i> The teaching activity is based four hours per week, on theoretical lessons and on solving the practical exercises which are previously set. In the facilities of the Centro de Cálculo, the students have to solve a series of application problems, so that they have to prepare several FORTRAN programs as course work.</p> <p><i>Assessment:</i> To pass the exam it is essential to have done the works during the course. Two final exams are held, one in June and another in September. In the final mark the marks of the works during the course and the practices done are taken into account.</p> <p><i>Teacher:</i> Fermín Navarrina Martínez, Ignasi Colominas Ezponda, Manuel Casteleiro Maldonado.</p>			
620	<p><b>Dams ©<sub>2</sub></b></p> <p><i>Description:</i> Design and calculation of dams. Management and exploitation.</p> <p><i>Aims:</i> To know the types of dams, project methods, construction and exploitation. To determine the actions to take into account to analyse its stability and tensional state. To determine the maximum flood. To know the systems of auscultation as well as the dimensions of the organs of outlet. To understand the influence of foundations in the behaviour of the dam.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction to the study of dams.</li> <li>2. Lessons of accidents.</li> <li>3. Actions to consider.</li> <li>4. Study of floods.</li> <li>5. Knowledge of the dam.</li> <li>6. Construction of dams and activities common to all types of dams.</li> <li>7. Dams of loose materials.</li> <li>8. Rockfill dams with reservoir.</li> <li>9. Other dams of loose material.</li> <li>10. Factory dams. Gravity dams.</li> <li>11. Factory dams. Arch dams.</li> <li>12. Dams of concrete compacted with roller.</li> <li>13. Spill ways.</li> <li>14. Deep outlets.</li> <li>15. Vigilance and auscultation of dams.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Tratado Básico de Presas</i>, E. Vallarino. Colegio de Ingenieros de Caminos.</li> <li>• <i>Advanced Dam Engineering</i>, R.B. Jansen. Van Nostrand Reinholds - N. York</li> <li>• <i>Handbook of Dam Engineering</i>, A.R. Golze. Van Nostrand Reinhold - N. York</li> <li>• <i>The Engineering of Large Dam</i>, H.H. Thomas. John Wiley Sons - N. York</li> <li>• <i>Design of Gravity Dam</i>. U.S. Bureau of Reclamation.</li> <li>• <i>Design of Archs Dam</i>. U.S. Bureau of Reclamation.</li> <li>• <i>Arch Dam</i>, Laginha Serafin. Balkena.</li> <li>• <i>Earth and Earth Rock Dam</i>, Sherard. John Wiley Sons - N. York.</li> <li>• <i>Presas de Tierra y Enroscamiento</i>, Marsal. Limusa</li> <li>• <i>Geotechnical Engineering of Embankment Dams</i>, Tell y otros. Balkena.</li> <li>• <i>Design of Small Dams</i>. U.S. Bureau of Reclamation.</li> </ul> <p><i>Teaching organization:</i> For four hours per week lectures in theory are given and previously set practices are resolved.</p> <p><i>Assessment:</i> In order to pass it is necessary to have done the course projects. Final exams are held in June and September.</p>	6  (4)	3	3

	<i>Teacher:</i> Rodrigo del Hoyo Fernández-Gago			
621	<p><b>Bridges I ©<sub>1</sub></b></p> <p><i>Description:</i> Bridges. Actions. Morphology. Straight bridges of short and medium spans. Slabs and decks. Spans. Support systems. Long span bridges.</p> <p><i>Aims:</i> To know the different typologies of straight bridges, their structural behaviour and the construction procedure employed. At the same time, to be able to distinguish the methods of calculation used in their analysis.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Design loads and regulations.</li> <li>3. Slab decks.</li> <li>4. Calculation of decks. Grillage methods.</li> <li>5. Calculation of decks: finite elements.</li> <li>6. Beam decks.</li> <li>7. Box section bridges.</li> <li>8. Substructure of bridges.</li> <li>9. Calculation of substructure.</li> <li>10. Oblique and curved- in- plan bridges.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• Arenas,J.J. y Aparicio, A.C. <i>Aparatos de apoyo para puentes y estructuras</i>. Servicio de Publicaciones, E.T.S.I.C.C.P., Santander.</li> <li>• Fernández Troyano,L. <i>Tierra sobre el agua. Visión histórica universal de los puentes</i>. Colegio de I.C.C.P.</li> <li>• Manterola,J. <i>Puentes I E.T.S. Ingenieros de C.C.y P.</i>, Madrid</li> <li>• Manterola,J. <i>Puentes II E.T.S. Ingenieros de C.C.y P.</i>, Madrid</li> <li>• SanmartínA. <i>Cálculo de estructuras de puentes de hormigón</i>. E. Rueda, Madrid.</li> <li>• O'Brien,E. <i>Bridge Deck Analysis</i>. Chapman and Hal</li> </ul> <p><i>Teaching organization:</i> For four hours a week lectures in theory are given and sessions of practical exercises are held. At the same time in the Laboratory of Computer Aided Calculation of Structures, models of bridge-decks and models of complete structures of bridges are designed to be resolved by means of Finite Elements programs.</p> <p><i>Assessment:</i> In order to pass the exam it is necessary to do the set course projects. Two final exams will be held in June and in September.</p> <p><i>Teacher:</i> Santiago Hernández Ibáñez</p>	6  (4)	3	3
622	<p><b>Bridges II ©<sub>2</sub></b></p> <p><i>Description:</i> Dual-web T-beams. Formworks. Advance in cantilevered beams. Thrust. Pull-off sources.</p> <p><i>Aims:</i> To describe the advanced typology of metallic, concrete and mixed bridges. To know the behaviour of bridges in the aeroelastic phenomena.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Straight bridges with special characteristics.</li> <li>2. Metal and mixed section bridges.</li> <li>3. Arch bridges.</li> <li>4. Cable-stayed bridges.</li> <li>5. Suspension bridges.</li> <li>6. Dynamic actions.</li> <li>7. The limits of design : new typologies and materials.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• Menn, C. <i>Prestressed Concrete Bridge</i>. Springer-Verlag, Viena.</li> <li>• Manterola,J. <i>Puentes III</i>. E.T.S. Ingenieros de C.C.y P., Madrid.</li> <li>• <i>Recomendaciones para el proyecto de puentes mixtos</i>,RPX-95. Ministerio de Fomento.</li> <li>• Gimsing, N.J. <i>Cable Supported Bridges</i>. John Wiley &amp; Sons Inc., New York.</li> <li>• Simiu, E. &amp; Scalan, R.H. <i>Wind Effects on Structures. Fundamentals and Applications to Design</i>. John Wiley &amp; Sons, 1996.</li> <li>• Rosignoli, M., <i>Launched Bridges</i>, ASCE Press.</li> </ul>	6  (4)	3	3

	<p><i>Teaching organization:</i> For four hours a week lectures in theory are given and sessions of practical exercises are held. At the same time in the Laboratory of Computer Aided Calculation of Structures, models of bridge-decks and models of complete structures of bridges are designed to be resolved by means of Finite Elements programs.</p> <p><i>Assessment:</i> In order to pass the exam it is necessary to do the set course projects. Two final exams will be held in June and in September.</p> <p><i>Teacher:</i> Santiago Hernández Ibáñez.</p>			
624	<p><b>Urban Services ©<sub>1</sub></b></p> <p><i>Description:</i> Distribution of water and sanitation networks. Gathering and eliminating rubbish. Cleaning roads. Control of atmospheric and noise contamination. Parks and gardens. Road conservation. Road lighting. Other services.</p> <p><i>Aims:</i> To instruct the student in the urbanization projects of the urban road network and the public spaces of the city.</p> <p><i>Syllabus:</i></p> <p>I. Urbanism and urban infrastructures.</p> <ol style="list-style-type: none"> <li>1.- Urban infrastructures and services.</li> <li>2.- Urban intervention and infraestructures.</li> <li>3.- Urban development.</li> <li>4.- The quality of urbanization and urban landscape.</li> </ol> <p>II. Urban public spaces: layout, urbanization and maintenance.</p> <ol style="list-style-type: none"> <li>5.- The urban public spaces.</li> <li>6.- Problems with component elements in the urban public spaces.</li> <li>7.- Causes of the problems.</li> <li>8.- Objectives of a reasonable policy about urban public spaces.</li> <li>9.- Recommendations of layout.</li> <li>10.- Recommendations of contour.</li> <li>11.- Recommendations of urbanization.</li> <li>12.- Recommendations of use and maintenance.</li> <li>13.-Road infrastructure.</li> </ol> <p>III. Urban services.</p> <ol style="list-style-type: none"> <li>14.- Systems of water supply.</li> <li>15.- Systems of cleaning and residual water treatment.</li> <li>16.- Electric energy and telecommunication network.</li> <li>17.- Gas provision.</li> <li>18.- Management of the collection and treatment of remainders.</li> <li>19.- Environmental control systems: noises, quality of the air and the water.</li> <li>20.- Road cleaning.</li> <li>21.- Furniture and public lighting system.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Metodología de los equipamientos urbanos</i> (1996); Jaime A. Manzano Gomez.</li> <li>• <i>Infraestructuras urbanas</i> (1999); Eduard Alabern Valentí, Carles Guilemany Casadamon.</li> <li>• <i>El urbanismo de las redes</i> (1998); Gabriel Dupuy.</li> <li>• <i>Instalaciones urbanas</i> (1990); Tomo I: <i>Diseño energético del entorno urbano</i>; Tomo II: <i>Infraestructura hidráulica y de evacuación de residuos</i>; Tomo III 1ª parte: <i>Infraestructura energética y de comunicaciones: distribución de energía eléctrica pública, sistemas de alumbrado urbano y redes urbanas de transmisión de información</i>; Tomo III 2ª parte: <i>Infraestructura energética y de comunicaciones: suministros de gases combustibles, distribución urbana de calefacción y agua caliente</i>; Luis Jesús Arizmendi Barnes.</li> <li>• <i>El soporte infraestructural de la ciudad</i> (2002); Manuel Herce Vallejo, Joan Miró Farrerons.</li> <li>• <i>La ingeniería en la evolución de la urbanística</i> (2002); Manuel Herce Vallejo, ed., Francese Magrinya Torner.</li> <li>• <i>Fundamentos del manejo de los residuos urbanos</i> (2000); Ernesto Hontoria García, Montserrat Zamorano Toro.</li> <li>• <i>Limpeza viaria</i> (1982); Jaime López Garrido, José Pereira Martínez, Rolando Rodríguez Acosta.</li> <li>• <i>Manual de conducciones Uralita. Sistemas de conducciones en infraestructuras, riego y edificación</i> (2004). Joaquín Suárez López, Fernando Martínez Abella, Jerónimo Puertas Agudo.</li> <li>• <i>GIS applications for water, wastewater and stormwater systems</i> (2005); U.M. Shamsi.</li> <li>• <i>Elementos urbanos</i> (1996); Josep Ma. Serra.</li> <li>• <i>Recomendaciones para el proyecto y diseño del viario urbano</i> (2000); Luis Felipe Manchón y Juan A. Santamera (M. de Fomento, Dirección General de la Vivienda, la Arquitectura y el Urbanismo).</li> <li>• <i>Espacios públicos urbanos, trazado, urbanización y mantenimiento</i> (1990); José Martínez Sarandeses, María Agustina Herrero Molina y María Medina Muro; Ministerio de Obras Públicas y Urbanismo, Instituto del Territorio y Urbanismo.</li> <li>• <i>Nuevos espacios urbanos</i> (2002); Jan Gehl y Lars gemzoe.</li> </ul>	6  (4)	3	3

	<p><i>Teaching organization:</i> The course has a theoretical component derived from the explanation of the program, and a practical component related to the composition of a project of the urbanization of a soil previously legislated for at a planning level, or of a free space of the badly urbanized city to recover it for public uses.</p> <p><i>Assessment:</i> For four hours per week lectures in theory and practical cases are given. The students made a work and one test. The student who does not follow this process of evaluation has the official examination session.</p> <p><i>Teacher:</i> Juan Cagiao Villar, Joaquín Suárez López, Alfredo Jácome Burgos.</p>			
625	<p><b>Expert Systems ©<sub>1</sub></b></p> <p><i>Description:</i> Representation of knowledge. Inference motors. Languages. Models.</p> <p><i>Aims:</i> To know, comprehend and apply the constructive methods of non -deterministic programming. To know the basic aspects of the artificial intelligence and of the engineering of knowledge. Apply the concepts in interesting cases for civil engineering.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction and general concepts.</li> <li>2. Resolution of problems in artificial intelligence.</li> <li>3. Schemes of representation of knowledge.</li> <li>4. Methods and models of reasoning.</li> <li>5. Engineering of knowledge and expert systems.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Principios de Inteligencia Artificial y Sistemas Expertos</i>, D.W.Rolston, McGraw-Hill, eds., 1990.</li> <li>• <i>Inteligencia Artificial</i>, E.Rich, Knight, Gustavo-Gili, eds., 1995</li> <li>• <i>Principios de Inteligencia Artificial</i>, Díaz de Santos, eds., 1987.</li> <li>• <i>A Guide to Expert Systems</i>, Addison-Wesley, eds., 1986.</li> <li>• <i>IEEE Expert</i> (Journal), IEEE Press.</li> </ul> <p><i>Teaching organization:</i> The teaching activity is based on theoretical lessons during four hours per week where problems are solved. During the course, specific course works are proposed and also a specific topic which is to be conceptualised, formalized, elicited and operationalised in order to design and develop a small expert system in the field of civil engineering.</p> <p><i>Assessment:</i> To pass the course it is essential to attend the lessons. The assessment is based on a final exam. In order to pass the course the student has to obtain a minimum mark. In the final mark the quality of the works presented in the lectures is taken into account.</p> <p><i>Teacher:</i> Vicente Moret Bonillo.</p>	6  (4)	3	3
626	<p><b>Optimisation Techniques</b></p> <p><i>Description:</i> Non-linear mathematical programming. Optimal design. Estimation of parameters. Control.</p>	6  (4)	3	3
628	<p><b>Urbanism II ©<sub>2</sub></b></p> <p><i>Description:</i> Constitutive processes and basic problems. Theory and practice of urbanism. Spanish technical- judicial contents. Historic evolution of urban knowledge. Study of the Spanish and European cases.</p> <p><i>Aims:</i> Basic theoretical and practical knowledge necessary for the elaboration, evaluation and carrying out of the Planning. The subject is structured in three parts: a) urban information, b) the elaboration of the planning and c) the execution and management of the planning detailed in the enclosed program.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1.1. Elements of territorial organic structure.</li> <li>1.2. Assessment of land: uses and aptitudes.</li> </ol>	6  (4)	3	3

	<p>1.3. The interpretation of urbanistic information.  2.1. Practice of urbanism: Objectives, interests and conflicts.  2.2. Legal framework. Previous acts and jurisdiction.  2.3. Instruments of planning and general classification of land.  2.4. Demarcation and qualification of land: zones and systems.  2.5. Regulation of actions: urban laws and ordinances of building.  2.6. Protection of the heritage and the environment.  2.7. Summary of that which was given previously and assessment of the planning proposals.  3.1. Programming of actions and economic study.  3.2. Control of planning and urban discipline.</p> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Elementos de Ordenación Urbana</i>, Juli Esteban i Noguera, Colegio de Arquitectos de Cataluña. Barcelona, 1981.</li> <li>• <i>Introducción al Planeamiento Urbano</i>, Juan A. Santamera, Colegio de Ingenieros de C.C. y P. Madrid, 1996.</li> <li>• <i>Texto Refundido de la Ley sobre el Régimen del Suelo y Ordenación Urbana y sus Reglamentos</i>, varios: B.O.E, Tecnos, Civitas,...</li> <li>• <i>Lei do Solo de Galicia</i>, varios: D.O.G.A, Xunta de Galicia,...</li> <li>• <i>Directrices para a Ordenación Urbanística dos Municipios Galegos</i>, Consellería de Ordenación do Territorio e Obras Públicas, Xunta de Galicia, 1992.</li> </ul> <p><b>Teaching organization:</b> Theoretical and practical lectures will be taught for four hours a week. The students will analyse real set tasks and will carry out the main contents of some planning figures.</p> <p><b>Assessment:</b> Continuous assessment, by means of following the course work and explanations of the students.</p> <p><b>Teacher:</b> Cándido López González.</p>			
630	<p><b>Management and Operation of Harbours ©<sub>2</sub></b></p> <p><b>Description:</b> Maritime transport. Harbour operations. Harbour construction works. Harbour planning. Organization and economic structure of harbour.</p> <p><b>Aims:</b> Specialised knowledge in the areas of transport, scheduling, management and operation of harbours. Users, goods, operations. Economic and administrative structure of harbours.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. The harbours.</li> <li>2. The port traffic.</li> <li>3. The structures and facilities of the harbours.</li> <li>4. The maritime transport contract.</li> <li>5. The users.</li> <li>6. Terminal management and operations.</li> <li>7. General cargo.</li> <li>8. General unified cargo. Containerisation.</li> <li>9. Solid bulks.</li> <li>10. Liquids bulks.</li> <li>11. Non conventional docks.</li> <li>12. The labour force.</li> <li>13. The harbours planning.</li> <li>14. The planning process.</li> <li>15. The structure of Spanish harbours.</li> <li>16. The economic structure.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Análisis económico del sistema portuario gallego</i>, González Laxe, F., et al, 1999. Instituto de Estudios Económicos. Fundación Barrié de la Maza.</li> <li>• <i>Dirección y explotación de puertos</i>, Rodríguez F., 1985. P. A. Bilbao.</li> <li>• <i>Libro Verde sobre los Puertos y las Infraestructuras Marítimas</i>, UE. CCE, 1997. Comisión de las Comunidades Europeas. Bruselas 10/12/1997.</li> <li>• <i>Los puertos de Europa. Guía de la organización de puertos europeos</i>, ESPO, 1998.</li> <li>• <i>Memorias de actividades. Anuarios estadísticos. Boletines de Información mensual</i>, ..., Fomento, Ente Público Puertos del Estado.</li> <li>• <i>Modelo europeo de excelencia empresarial para el sector público. Autoridad portuaria: Caso práctico</i>, Fundación portuaria, 1999. European Foundation for Quality Management EFQM.</li> <li>• <i>The business of shipping</i>, Kendall, L. C. &amp; Buckley, J. J., 1994. 6th ed. Cornell Maritime Press.</li> <li>• <i>Transportes Marítimos de Línea Regular</i>, Blanco, A., 1997. A. P. Valencia.</li> <li>• <i>Dirección y explotación de puertos</i>, Rodríguez F., P. A. Bilbao, 1985</li> </ul>	6  (4)	3	3

	<p><i>Teaching organization:</i> During four hours a week lectures will be made up of theory, and outline and solve examples in order to achieve the participation of the student. Different applications will be proposed which will constitute the course work</p> <p><i>Assessment:</i> It is necessary to do the course work. There will be an exam in July and another in September. The aptness and originality of the solutions given to the examples set during the course as well as the practical exercises handed in will be taken into account in the final marks.</p> <p><i>Teacher:</i> Juan R. Acinas García y Gregorio Iglesias Rodríguez.</p>			
631	<p><b>Computer Assisted Design and Visualization ©<sub>1</sub></b></p> <p><i>Description:</i> Computer assisted design. Modelling of surfaces and solids. Digital treatment of images. Advanced visualization and animation.</p> <p><i>Aims:</i> The course aims to teach the basis and theoretical fundamentals of Computer Aided Design, Advanced Visualization and Computer Animation applied to Civil Engineering. Praxis includes training on the use of CAD commercial packages to obtain blueprints and to generate realistic images of 3D models.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. History of Representation in Engineering.</li> <li>2. Matrix Geometrical Operators.</li> <li>3. Parametric curves and surfaces.</li> <li>4. Modelling systems.</li> <li>5. Architecture of personal computers.</li> <li>6. Computer visualisation.</li> <li>7. Graphic File Formats.</li> <li>8. Visualisation of large models.</li> </ol> <p>Practical work.</p> <p>Learning and use of conventional programs of aided design, three- dimensional modelling and advanced visualisation.</p> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>A History of Engineering Drawing</i>, Booker P; Northgate 1979.</li> <li>• <i>Computer Graphics, Principles and Practice</i> Foley, J, et Al. Addison Wesley, 1990</li> <li>• <i>Computer Graphics and Geometric Modeling for Engineers</i>, Anand V.; J. Wiley S., 1993.</li> <li>• <i>Matematical Elements for Computer Graphics</i>, Rogers D., Adams J.; McGraw-Hill, 1990.</li> <li>• <i>Procedural Elements for Computer Graphics</i>, Rogers D.; McGraw-Hill, 1985.</li> <li>• <i>Advanced Animation and Rendering Techniques</i>, Watt A., Watt M.; Addison Wesley, 1992.</li> <li>• <i>Graphics File Formats</i>, Kay D., Levine J.; McGraw-Hill, 1995.</li> <li>• AutoCAD 2000, Dix, M. Riley, P; Prentice Hall,, 2000.</li> <li>•</li> </ul> <p><i>Teaching organization:</i> Classes last 4 hours/week including theory on computer graphics and praxis using CAD programs, with exercises and application to real cases for a better understanding of theoretical foundations. Students must elaborate a coursework related to the 2D and 3D representation of a real case.</p> <p><i>Assessment:</i> The students must pass an examination and complete a course project.</p> <p><i>Teacher:</i> Luis A. Hernández Ibáñez.</p>	6  (4)	3	3
632	<p><b>Optimum Design of Structures ©<sub>2</sub></b></p> <p><i>Description:</i> Optimal design. Analysis of sensibility. Optimisation of transversal sections of bar structures. Optimisation of moulds.</p> <p><i>Aims:</i> To define the approach to the problem of optimum design of structures. To teach the methods of linear optimisation and the most habitual non- linear methods. To describe the concept of analysis of sensibility and the methods of achieving it. To show applications of optimum design in different structural typologies. To inform students of the features of the computer programs of optimum design that currently exist.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Approach to optimum design.</li> <li>2. Simple examples of optimum design of structures.</li> <li>3. Optimising by criteria assigning.</li> </ol>	6  (4)	3	3

	<p>4. Mathematical context of optimum design.  5. Methods of linear programming.  6. Unconditioned optimizing.  7. Conditioned optimizing.  8. Description of a code of mathematic optimizing: ads.  9. Analysis of sensibility.  10. Optimizing of structures of articulated joints.  11. Optimizing of structures of rigid junctions.  12. Description of a code of optimum design og structure: genesis.</p> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Métodos de diseño óptimo de estructuras</i>, Santiago Hernández, Colegio de Ingenieros de Caminos, C. y P.</li> <li>• <i>Numerical Optimization Techniques for Engineering Design: With Applications</i>, G.N. Vanderplaats, McGraw-Hill.</li> <li>• <i>Elements of Structural Optimization</i>, R.T. Haftka, Z. Gurdal y M.P. Kamat, Kluwer Academic.</li> <li>• <i>Introduction to Optimum Design</i>, U. Kirsch, McGraw-Hill.</li> <li>• <i>Introduction to Optimum Design</i>, J. Arora, McGraw-Hill.</li> </ul> <p><b>Teaching organization:</b> Theoretical lectures will be imparted for four hours a week and proposed problems will be solved in the practice papers. In the <i>Laboratory of Computer Aided Calculation of Structures</i> optimum designs of structures will be obtained through the programs ADS and COSMOS/M.</p> <p><b>Assessment:</b> In order to pass the course it is necessary to have performed and passed the course work. Exams will be held at the end of June and September and in the final mark the mark of the exam and the course work it will be taken into account.</p> <p><b>Teacher:</b> Santiago Hernández Ibáñez y Juan Carlos Perezzan Pardo.</p>			
633	<p><b>Technical Operation of Railways ©<sub>2</sub></b></p> <p><b>Description:</b> The movement of the train. Railway exploitation. Special railway systems: the underground, high speed trains, weak traffic lines.</p> <p><b>Aims:</b> To know those specific aspects relative to railway terminals for passengers and goods. To identify and to differentiate the rolling equipment characteristics, as well as the specific phenomena involved in vehicle movements. To characterize the main elements of the electrification, signalling, security, communications and operation systems. To identify and differentiate the technical and commercial operations, as well as their suitability for certain situations. To describe the organization and administration of the railway activity.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Rail transportation terminals. <ul style="list-style-type: none"> <li>-Station with passengers.</li> <li>-Goods station.</li> </ul> </li> <li>2. Introduction to rolling equipment. <ul style="list-style-type: none"> <li>-Rolling equipment. Classes of towed material.</li> </ul> </li> <li>3. Train dynamics. <ul style="list-style-type: none"> <li>- The adhesion and the traction.</li> <li>- Resistance and efforts.</li> <li>- The braking of the trains.</li> <li>- The material in movement.</li> </ul> </li> <li>4. Traction. <ul style="list-style-type: none"> <li>- The electrical traction.</li> <li>- The line of contact and the circuit of return.</li> <li>- The locomotive. Mechanical part.</li> <li>- The locomotive. Electrical and thermal traction.</li> </ul> </li> <li>5. Operation. <ul style="list-style-type: none"> <li>-Railway signals</li> <li>-Introduction to enclave.</li> <li>- Communications.</li> <li>-Actual systems of operation.</li> <li>- Traffic capacity.</li> <li>-Tariff</li> <li>-Environmental impact of the railroad.</li> </ul> </li> <li>6. Rail system. <ul style="list-style-type: none"> <li>-The underground.</li> <li>-The slight underground.</li> <li>-Railroad with high speed.</li> <li>-Lines with weak traffic.</li> <li>-No conventional railroad.</li> </ul> </li> </ol>	6  (4)	3	3



	<p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Ferrocarriles</i>, García Díaz-de-Villegas, J.M. Publicaciones de la E.T.S. Ingenieros de Caminos, Santander, 2000.</li> <li>• <i>Tratado de Ferrocarriles</i>, Oliveros Rives, F., López Pita, A. y Mejía Puente, M., Editorial Rueda, Madrid, 1977.</li> <li>• <i>Tratado de Explotación de Ferrocarriles (I)</i>, Oliveros Rives, F., Rodríguez Menéndez, M. y Mejía Puente, M., Editorial Rueda, Madrid, 1983.</li> <li>• <i>Operación de Trenes de Viajeros</i>, García Álvarez, A., Cillero Hernández, A., Rodríguez Jericó, P., Fundación de los Ferrocarriles Españoles, Madrid, 1998.</li> </ul> <p><b>Teaching organization:</b> During 4 hours a week, theory lectures are imparted and numerical examples are solved. Technical visits are organized to railway installations in the region.</p> <p><b>Assessment:</b> A final exam is held, with a theoretical part and another with numerical questions. To pass the course it is required to pass both parts.</p> <p><b>Teacher:</b> Miguel Rodríguez Bugarín y Margarita Novales Ordax.</p>			
634	<p><b>Underground Hydrology ©<sub>1</sub></b></p> <p><b>Description:</b> Underground flow. Aquifer mechanics: hydraulics of catchments. Aquifers and superficial waters. Marine intrusion. Hydrochemical and contamination. Exploitation and management.</p> <p><b>Aims:</b> To give a general and balanced view of the basic and applied aspects of Underground Hydrology from the necessities of the civil engineer.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Theory of the flow of underground water.</li> <li>3. Flow in aquifers.</li> <li>4. Exploration and management of aquifers.</li> <li>5. Hydraulics of uptakes.</li> <li>6. Hydrochemicals and quality of underground waters.</li> <li>7. Numeric modelization of aquifers.</li> <li>8. Application of underground hydrology to civil engineering and real cases.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Hidrología Subterránea</i>, Custodio, E., Llamas, M.R., Editorial Omega, S.A., 1983.</li> <li>• <i>Quantitative Hydrogeology</i>, De Marsily, G. Academic Press. San Diego, 1987.</li> <li>• <i>Groundwater</i>, Freze, R.A.; Cherry, J.A. Prentice Hall, 1979</li> <li>• <i>Physical and Chemical Hydrogeology</i>, Domenico P. y F. Schwartz, 1990.</li> <li>• <i>Analysis and evaluation of pumping test data</i>, Kruseman, H.; De Ridder, J. Inter. Inst. For Land Reclamation and Improvement. Wageningen, Holanda, 1970.</li> <li>• <i>Applied hydrogeology</i>, Fetter, C.W. JR., Ch. E. Merrills Pub., 1980.</li> <li>• <i>Introduction to groundwater modeling: finite difference and finite element methods</i>, Wang, H.F.; Anderson, M.P., W.H. Freeman &amp; Co. San Francisco, 1982.</li> </ul> <p><b>Teaching organization:</b> This is a four- month course which consists of four hours per week grouped two by two. It is developed by lessons which combine a sufficient theoretical knowledge with the practical applicability of the material, and the commentary on real cases. Throughout the course a series of problems are given to the students to be solved. Once they are corrected, the problems are explained and commented on in the classroom. The latter is completed with laboratory sessions, and field trips.</p> <p><b>Assessment:</b> To pass the exam it is necessary: to do the set exercises satisfactorily, to have carried out the field trips and laboratory practices correctly and to do an individual course project.</p> <p><b>Teacher:</b> Ricardo Juncosa Rivera y Javier Samper Calvete, Jorge Molinero Huguet.</p>	6 (4)	3	3
635	<p><b>History of Art ©<sub>1</sub></b></p> <p><b>Description:</b> History of Art. Art throughout history: Old Age, Middle Age, Modern</p>	6 (4)	3	3

	<p>Age and Contemporary Age.</p> <p><i>Aims:</i> To know and understand the different artistic styles, in relation to the historic, economic and social context of the epoch.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Theory and function of art.</li> <li>2. Greek architecture.</li> <li>3. Roman architecture.</li> <li>4. Paleo-Christian and Byzantine art.</li> <li>5. Pre-Romanic art.</li> <li>6. Contributions of Islamic art.</li> <li>7. Romanic art.</li> <li>8. Gothic art.</li> <li>9. The renaissance.</li> <li>10. The renaissance in Spain.</li> <li>11. Baroque European architecture.</li> <li>12. From rococo to neo-Classicism.</li> <li>13. The architecture of the 19<sup>th</sup> century.</li> <li>14. Impressionism and post- impressionism.</li> <li>15. The avant-garde movements of the 20<sup>th</sup> century.</li> <li>16. Architecture of the 20<sup>th</sup> century.</li> <li>17. The artistic panorama since 1945</li> <li>18. Art and the new technologies.</li> <li>19. Video and computer. Photography. The art markets.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Historia del Arte</i>, Gombrich E.H.; Alianza, Madrid, 1997.</li> <li>• <i>Arquitectura de la prehistoria a la postmodernidad</i>, Trachtenberg M.H., Man I.; Akal, Madrid, 1990.</li> <li>• <i>El Arte Moderno</i>, Argan G.C.; Akal, Madrid, 1991.</li> <li>• <i>Historia General del Arte</i>, Janson H.W.; Alianza, Madrid, 1995.</li> </ul> <p><i>Teaching organization:</i> For four hours per week theoretical and practical classes are given.</p> <p><i>Assessment:</i> Two final exams will be held, one in June and the other in September.</p> <p><i>Teacher:</i> Josefina Cerviño Lago</p>			
636	<p><b>Engineering of Urban Sewage Systems ©<sub>2</sub></b></p> <p><i>Description:</i> Integral sanitation. Drainage and sanitation networks. Control systems and treatment of overflow. Advanced processes. Purification.</p> <p><i>Aims:</i> To improve the students' capacity for design and project in solutions of the sewage systems, drainage and advanced management of the waste waters of the city. To make progress in the knowledge of advanced processes of purification for the elimination of nutrients and to know the strategies of management of waters in rain time.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Systems of integral and integrated sewage system.</li> <li>2. Urban drainage.</li> <li>3. Biofilms treatment of waste waters.</li> <li>4. Processes of elimination of nutrients bases in suspended biomass. Elimination of phosphorus.</li> <li>6. Contamination of urban run-off water new techniques of management of rain waters.</li> <li>7. Design of biological processes with the aid of computer programs.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Curso de hidrología urbana</i>", Universidad Politécnica de Cataluña, Barcelona, Noviembre de 1995.</li> <li>• <i>Instrucción de carreteras 5.2.I.C"</i>; MOPU, Madrid,1990.</li> <li>• <i>Introduction to Hydrology"</i>; Viessman, W., Lewis, G., Knapp, J., Harper, Nueva York, 1989.</li> <li>• <i>Ingeniería de Aguas Residuales. Tratamiento, vertido y reutilización"</i>; Metcalf&amp;Eddy, Tercera Edición, 1995.</li> <li>• <i>Ingeniería de Aguas Residuales. Redes de alcantarillado y bombeo."</i>; Metcalf&amp;Eddy,; 1995.</li> <li>• <i>"Curso sobre tratamiento de aguas residuales y explotación de estaciones depuradoras"</i>, dos tomos, CEDEX, Centro de Estudios y Experimentación de Obras Públicas, Ministerio de Obras Públicas y Transportes, Gabinete de Formación y Documentación, Madrid, 1982.</li> <li>• <i>"Tratamiento biológico de las aguas residuales"</i>, Ronzano, E., Dapena, J.L.; PRIDES,;</li> </ul>	6  (4)	3	3

	<p>Ediciones Díaz.</p> <p><i>Teaching organization:</i> Three types of activities will be carried out: theoretical lessons, practical lectures on design and dimensioning of solutions of the sewage system, drainage and purifying and practice sessions with computer programs.</p> <p><i>Assessment:</i> Three compulsory works and three partial exams will be carried out. Finally an end- of- the- year exam will be held.</p> <p><i>Teacher:</i> Joaquín Suárez López.</p>			
637	<p><b>Materials and Construction Systems ©<sub>2</sub></b></p> <p><i>Description:</i> Advanced materials construction technology. Constructive procedures. Pathology and preparation of structures.</p> <p><i>Aims:</i> To improve the knowledge in Construction Engineering covering new construction materials, analysis methods and construction of particular structural elements and structure pathologies and repair.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Special materials. <ul style="list-style-type: none"> <li>- Materials with cement base.</li> <li>- Metallic materials.</li> <li>- Compound materials.</li> </ul> </li> <li>2. Constructive systems.</li> <li>3. Pathology and repair of concrete and steel structures. <ul style="list-style-type: none"> <li>- Pathology.</li> <li>- Repairs.</li> </ul> </li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Concrete Technology. New Trends, Industrial Applications</i>, Proceedings of the International Rilem Workshop, editado por A. Aguado, R. Gettu y S.P. Shah, E &amp; FN Spon Chapman &amp; Hall, Londres, 1995.</li> <li>• <i>Hormigones de Alta Resistencia</i>, GT I/2 del GEHO, Boletín 20 del GEHO, Madrid, 1997.</li> <li>• <i>Patología de Estructuras de Hormigón Armado y Pretensado</i>, J. Calavera, INTEMAC, Madrid, 1996.</li> <li>• <i>El Estado del Arte en Reparación y Refuerzo de Estructuras de Hormigón</i>, Diversos Autores, GEHO, Madrid, 1995.</li> <li>• <i>Sostenimiento del Hormigón</i>, TMC, Madrid, 1995.</li> </ul> <p><i>Teaching organization:</i> Theoretical and practical lectures are complemented with worksite visits, special topic seminars, laboratory work and conferences by invited building designers and specialists.</p> <p><i>Assessment:</i> A compulsory laboratory project must be developed and publicly presented.</p> <p><i>Teacher:</i> Fernando Martínez Abella, Cristina Vázquez Herrero, Belén González Fonteboa.</p>	6  (4)	3	3
638	<p><b>Rock Mechanics ©<sub>1</sub></b></p> <p><i>Description:</i> Characterization of the rock massifs. Geo-mechanic classifications. Property of the rock matrix. Laboratory techniques. Mechanics of joints.</p> <p><i>Aims:</i> To introduce the student to basic knowledge in relation to rock mechanics.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Description of the structural domain.</li> <li>3. Graphical representation of discontinuities.</li> <li>4. "In situ" stresses. Origin and quantification.</li> <li>5. Matrix rock properties. Tests. Tensile-deformational behaviour of the rock matrix.</li> <li>6. Mechanical behaviour of joints.</li> <li>7. Rock massif strength.</li> <li>8. Survey techniques.</li> <li>9. Calculation methods</li> <li>10. Water flow in rock massifs.</li> </ol>	6  (4)	3	3

	<p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Underground excavations in Rocks</i>, E. Hoek y E.T. Brown, Institution of Mining and Metallurgy, 1980.</li> <li>• <i>Rock Slope Engineering</i>, E. Hoek y J.W. Bray, Institution of Mining and Metallurgy, 1981.</li> <li>• <i>Introduction to Rock Mechanics</i>, R.E. Goodman, Wiley, 1989.</li> <li>• <i>Stereographic projection techniques</i>, P.R. Leyshon y R.J. Lisle, Butterworth, 1996.</li> </ul> <p><b>Teaching organization:</b> Lectures in theory, practical lessons and selected field trips.</p> <p><b>Assessment:</b> Evaluation will be based on tests covering the knowledge acquired on the discipline, both in theoretical and practical aspects. In the final marks active participation in the lectures and field sessions will be taken into account. A report related to the subjects of the course could be asked for.</p> <p><b>Teacher:</b> Jordi Delgado Martín.</p>			
639	<p><b>Decision Taking in Engineering ©<sub>2</sub></b></p> <p><b>Description:</b> Bayesian statistics. Hindsight decisions. Variance analysis. Control of quality.</p> <p><b>Aims:</b> To show the basic criteria which were used in a rational and objective way at the time of taking decisions inside a group of possibilities and, besides to acquire the exact knowledge in order to do analysis and rational criticism of actions.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Games.</li> <li>2. Decisions in atmosphere of uncertainty.</li> <li>3. Decisions without experimentation.</li> <li>4. Decisions with experimentation.</li> <li>5. Synthesis of judgements.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Probability, Statistics and Decision for Civil Engineers</i>, Benjamin J.R. y Cornell C. McGraw-Hill, New York, 1970.</li> <li>• <i>Teoría de la decisión</i>, White D.J. Alianza Editorial, Madrid, 1990.</li> <li>• <i>Introducción a la teoría de juegos</i>, Morton D. Davis. Alianza Editorial, Madrid 1986.</li> <li>• <i>Teoría de los juegos (6 volúmenes)</i>, Girón González-Torre F. J. UNED, Madrid, 1977.</li> <li>• <i>Teoría de la decisión (6 volúmenes)</i>, Infante Macias R. UNED, Madrid, 1978.</li> <li>• <i>Programación Lineal: Metodología y problemas</i>, Mocholi Arce, M. ; Sala Garrido, R. Editorial Tebar Flores, Albacete, 1993.</li> <li>• <i>Principios de la teoría de la decisión</i>, Lindley D.V. Ed. Vincens-Vives, Barcelona, 1977.</li> <li>• <i>Métodos de diseño óptimo de estructuras</i>, Hernández S., Colegio I.C.C.P., Madrid, 1990.</li> <li>• <i>Teoría de la decisión multicriterio: Conceptos, técnicas y aplicaciones</i>, Romero C. Alianza Universidad, Madrid, 1993.</li> <li>• <i>Teoría de juegos</i>, Binmore K. McGraw-Hill, Madrid, 1994.</li> </ul> <p><b>Teaching organization:</b> The teaching activity is based on four hours per week, on theoretical and practical lessons and on solving the practical exercises.</p> <p><b>Assessment:</b> It is essential to have done the works set along the course. The assessment is based on two final exams, June and September. The course can also be passed doing the works set by the teachers of the subject before the 30th of June.</p> <p><b>Teacher:</b> Ramón Martul Álvarez de Neyra y Manuel Casteleiro Maldonado.</p>	6  (4)	3	3
640	<p><b>Urbanism I ©<sub>1</sub></b></p> <p><b>Description:</b> The city throughout history. The urban growth theory. Analysis elements of urban structure.</p> <p><b>Aims:</b> To introduce the student to the knowledge of urbanism, understood as the science which orders the territory and the activities which are carried out on it. The course is based on the analysis of the models and elements of organization and will serve as introduction and complement to the rest of the subjects in the field.</p> <p><b>Syllabus:</b></p>	6  (4)	3	3

	<p>1. Urbanization of territory.  2. Territorial structure of rural areas.  3. Interpretation of urbanistic information.  4. Residential forms of the city of the 18<sup>th</sup> and 19<sup>th</sup> century.  5. Proposals of new models of the city.  6. Residential forms of modern movement.  7. Forms of growth of the current city.  8. Regulation of roads and building in residential areas.  9. Regulation of roads and building in industrial areas.  10. Ordinances of building and organization.  11. Public space of the city.  12. Installations of the city.  13. The objectives of urban planning.</p> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>El medio rural y la práctica del urbanismo en Galicia: contradicciones</i>, Manuel Gallego Jorreto. Edicións Galaxia, A Coruña, 1975.</li> <li>• <i>Resumen histórico del urbanismo en España</i>, García Bellido y otros, Instituto de la Administración Local, Madrid, 1997.</li> <li>• <i>Historia del urbanismo en Europa 1750-1960</i>, Benedetto Gravagnolo, Ediciones Akal, Madrid, 1998.</li> <li>• <i>La práctica del urbanismo</i>, Sir Raymon Unwin, Gustavo Gili, Barcelona 1984.</li> <li>• <i>Diseño de la ciudad-5</i>, Leonardo Benevolo, Gustavo Gili, Barcelona 1982.</li> <li>• <i>Las formas de crecimiento urbano</i>, Manuel de Solá Morales i Rubió, Ediciones UPC, Barcelona, 1997.</li> <li>• <i>Nuevos territorios, nuevos paisajes</i>, Varios autores, Actar, Barcelona 1997.</li> </ul> <p><b>Teaching organization:</b> For 4 hours a week, theoretical and practical lectures will be imparted. The students will analyse different proposals of organization and will elaborate their own using the models and elements studied.</p> <p><b>Assessment:</b> Continuous assessment, through the following up of the course work and explanations of the students.</p> <p><b>Teacher:</b> Juan Creus Andrade.</p>			
641	<p><b>Technical Project</b></p> <p><b>Description:</b> In-depth definition of technological aspects of a project. Carrying out a study or report on a specific theme of the professional field or a project related to research and development in engineering.</p>	6  (4)	3	3
642	<p><b>Roads and Airports II ©<sub>2</sub></b></p> <p><b>Description:</b> Further study of traffic engineering. Amplification of road layouts. Amplification of pavement and road beds.</p> <p><b>Aims:</b> To amplify the knowledge of the layout and the pavement design, acquired in the subject of Roads and Airports. The methods of exploitation of roads.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Amplification of layout of roads.</li> <li>2. Signaling of roads.</li> <li>3. Structural analysis of road surfaces.</li> <li>4. Conservation of roads.</li> <li>5. Road legislation.</li> <li>6. Airports.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>Normativa vigente del Ministerio de Fomento</i>, Instrucción de carreteras, PG-3/75 modificado, Instrucción de drenaje 5.2.I.C.</li> <li>• <i>Colección de libros: Trafico, explanaciones y drenajes, trazado de carreteras, y firmes</i>, Kraemer C., E.T.S. de Ingenieros de Caminos de Madrid.</li> <li>• <i>Carreteras Urbanas. Recomendaciones para su planeamiento y proyecto</i>. MOPT.</li> <li>• <i>Pavement Analysis and Design</i>. Yang H. Huang</li> <li>• <i>Proyecto y Construcción de Carreteras</i>. G. Jeuffroy</li> <li>• <i>Planificación y diseño de aeropuertos</i>. Robert Horonjeff</li> <li>• Revistas <i>CEDEX</i> y <i>Carreteras</i>.</li> </ul> <p><b>Teaching organization:</b> Theoretical lectures are taught and practical exercises of the set themes are put forward for four hours a week. In parallel laboratory practices referring</p>	6  (4)	3	3

	<p>to the basic tests explained in the theoretical lectures are carried out. Didactic visits to works and acts related to the aims of the subject are carried out.</p> <p><i>Assessment:</i> The assessment of the subject is carried out by means of a final exam and the participation in the lectures. The submitting of the set practices is also taken into account.</p> <p><i>Teacher:</i> José Ramón Fernández de Mesa Díaz del Río</p>			
653	<p><b>Water Resources and Hydraulic Planning ©<sub>2</sub></b></p> <p><i>Description:</i> Hydraulic planning and regulation. Optimisation of resources theory. Linear programming and applications.</p> <p><i>Aims:</i> To provide the students with the principles of water resources assessment and the hydraulic planning tools.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Introduction.</li> <li>2. Water resources.</li> <li>3. Water resources assessment.</li> <li>4. Study of ground water.</li> <li>5. Study of surface water.</li> <li>6. Water demand.</li> <li>7. Water resource systems.</li> <li>8. Joint use.</li> <li>9. Quality and pollution.</li> <li>10. Water resources planning in Spain.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Conceptos y métodos para la planificación hidrológica</i>, Andreu J., Ed. CIMNE, 1993.</li> <li>• <i>Principles of Water Resources Planning</i>, Goodman A., Prentice-Hall, 1984.</li> <li>• <i>Recursos Hidráulicos y su Planificación</i>, Liria J. y Sáinz J.A., Apuntes de la ETSICCP de Santander, 1982.</li> <li>• <i>Water Resource Systems Planning and Analysis</i>, Loucks D., Stedinger J. y Haith D., Prentice-Hall, 1981.</li> <li>• <i>Planificación Hidráulica</i>, Vallarino E., Apuntes de la ETSICCP de Madrid, 1980.</li> <li>• <i>Modelos matemáticos para la evaluación de los recursos hídricos</i>, Teodoro Estrela. CEDEX, 1993.</li> <li>• <i>Recomendaciones para el cálculo hidrometeorológico de avenidas</i>, F. Javier Ferrer Polo, 1993.</li> <li>• <i>Metodología aplicada a estudios de regulación</i>, Sainz, J.A. y Ascorbe, A.; Univ. de Santander, 1984.</li> <li>• <i>Gestión de recursos hídricos</i>, Baladrón, L.; E.U.I.T. Obras Públicas de Ávila, Universidad de Salamanca, 2000.</li> </ul> <p><i>Teaching organization:</i> The theoretical teaching of the course consists of 4 hours per week that will be completed with conferences on experimental and actual cases by invited specialists. During the academic year the lecturers will distribute several exercises about the subjects of the course in order to evaluate the students efficiency. The students should also carry out a team project on hydrologic planning that will also contribute to the assessment of the course.</p> <p><i>Assessment:</i> The final qualification of the course will be calculated by means of the partial evaluations obtained in the exercises and projects carried out by the students.</p> <p><i>Teacher:</i> Ricardo Juncosa Rivera, Francisco Padilla Benítez, Rodrigo del Hoyo Fernández-Gago.</p>	6 (4)	3	3
657	<p><b>Typology of Structures ©<sub>1</sub></b></p> <p><i>Description:</i> Structural forms. Typological study. Structural systems. Typology of high buildings. Implementation processes. Aesthetic expression.</p> <p><i>Aims:</i> To describe the most used structural schemes in engineering. To analyze historical background and its evolution through time. To understand the interactions between the structural typology, the existing materials of construction in each historical time and the calculation methods.</p>	6 (4)	3	3

	<p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Aspects associated with the process of design.</li> <li>2. Massive structures.</li> <li>3. The beam.</li> <li>4. The arch.</li> <li>5. The lattice.</li> <li>6. Porticos.</li> <li>7. Sheets.</li> <li>8. Slabs.</li> <li>9. Particular loads in structures.</li> <li>10. Form and function.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• “Razón de ser de los tipos estructurales”, E. Torroja, CSIC.</li> <li>• “Structures”, J.E. Gordon, Penguin.</li> <li>• “Torri”, Heinle, E., Leonhardt, F., Mondadori.</li> <li>• “Bridges”, G. Outerbridge, H.N. Abrams Publishers.</li> <li>• “Puentes y sus constructores”, Steinman, D.B., Watson, S.R., Colegio de I.C.C.P.</li> <li>• <i>The Tower and the Bridge</i>, D.P. Billington, Princeton University Press.</li> </ul> <p><b>Teaching organization:</b> The teaching activity is based on theoretical lessons four hours per week and on solving structural models using computer programs.</p> <p><b>Assessment:</b> In order to pass it is necessary to submit the proposed coursework. End-of-the-year exams are held in June and September.</p> <p><b>Teacher:</b> Santiago Hernández Ibáñez y José Ángel Jurado Albarracín-Martinón..</p>			
658	<p><b>Landscape in Engineering ©<sub>2</sub></b></p> <p><b>Description:</b> Engineering and nature. The landscape as an environmental factor. Methodology of study and valuing of the landscape. Analysis of the landscape impact. Highway, expressways and landscape. Hydraulic works and the landscape. Maritime works and the landscape.</p> <p><b>Aims:</b> The subject deals with confronting the student with the project of an engineering work from the scale of the place, in which he intervenes and transforms. The landscape which the student studies in this sense, it is not only the natural one but also the rural, the urban and the one created and transformed by the work of engineering itself, with which is related perceptively and through the elements of which it is composed and which characterize it.</p> <p><b>Syllabus:</b></p> <ol style="list-style-type: none"> <li>1. Ability of the engineer confronting nature.</li> <li>2. Scales of approximation to landscape of engineering.</li> <li>3. Methods of analysis and assessment of the landscape.</li> <li>4. The natural landscape.</li> <li>5. The rural landscape.</li> <li>6. The urban landscape.</li> <li>7. The landscape of the bridge.</li> <li>8. The landscape of the road.</li> <li>9. The landscape of ports.</li> <li>10. The coastal landscape.</li> <li>11. The fluvial landscape.</li> </ol> <p><b>Bibliography:</b></p> <ul style="list-style-type: none"> <li>• <i>I Jornadas Internacionales sobre Paisajismo</i>. Santiago de Compostela 1991. Colegio de Ingenieros de Caminos, C. y P. de Galicia. Xunta de Galicia.</li> <li>• <i>El Pensamiento Estético de los Ingenieros. Funcionalidad y Belleza</i>, Discurso de José Antonio Fernández Ordóñez en la Real Academia de Bellas Artes de San Fernando. Madrid 1990.</li> <li>• <i>Ingeniería Civil y Medio Ambiente</i>. CEOTMA MOPU. Serie Monografías 10. 1981.</li> <li>• <i>El Paisaje</i>, Escribano Bombin, M. y otros. Serie Unidades Temáticas Ambientales del MOPT 1991.</li> <li>• <i>Ponts, Puentes</i>, Fritz Leonhardt. Press Polytechnique Romands 1982.</li> <li>• <i>El diseño de Vías Urbanas</i>, Jim. Mc Cluskey 1992. Ed. Gustavo Gili 1985.</li> </ul> <p><b>Teaching organization:</b> The course has a theoretical component expressed in the syllabus of the subject and a practical component which tries to confront the student with the previous approaches to the project through the language of reality itself.</p> <p><b>Assessment:</b> The assessment is based on a practical exercise in which the students identify the natural and artificial components which typify the landscape; they also do</p>	6  (4)	3	3



	<p>a visual and aesthetic analysis of the quality of the contents and study the alternatives to the necessary interventions which existed in order to restore it.</p> <p><i>Teacher:</i> Carlos Nárdiz Ortiz.</p>			
659	<p><b>Transport Planning ©<sub>2</sub></b></p> <p><i>Description:</i> Planning. Sectorial and integral plans of transport. Evaluation and selection of projects. Transport policies: Spanish and European.</p> <p><i>Aims:</i> To explain the essential features of Transport Planning: The Planning Process. Spanish and European Transport Politics. Planning Studies. Transport Models. Transport Project Evaluation and Choice.</p> <p><i>Syllabus:</i></p> <ol style="list-style-type: none"> <li>1. Transport planning.</li> <li>2. Transport planning in Spain.</li> <li>3. European union transport policy.</li> <li>4. Transport planning studies.</li> <li>5. Transport models.</li> <li>6. Transport project evaluation and choice.</li> </ol> <p><i>Bibliography:</i></p> <ul style="list-style-type: none"> <li>• <i>Modelling Transport 2nd Ed.</i>, Ortúzar, J de D., Willumsen, L.G.. John Wiley &amp; Sons, West Sussex (England) 1994.</li> <li>• <i>Modelos de Demanda de Transporte 2ª Edición</i>, Ortúzar, J. de D. Alfaomega, Ed. Universidad Católica de Chile. México, 2000.</li> <li>• <i>Manual para la evaluación de inversiones de transporte en las ciudades</i>, AA.VV. Centro de Publicaciones M° de Fomento, Madrid, 1996.</li> <li>• <i>Transportation Planning Handbook</i>, AA. VV. Institute of Transportation Engineers. Prentice Hall, New Jersey, 1992</li> <li>• <i>Transportes. Un enfoque integral</i>, Izquierdo, R. Publicaciones del Colegio de Ingenieros de Caminos, Madrid, 1994.</li> <li>• <i>Transportes</i>, Ibeas, A., Díaz, J.M. Servicio de Publicaciones, E.T.S.I.C.C.P. Santander, 1998.</li> </ul> <p><i>Teaching organization:</i> The theoretical lectures are carried out together with the solving of some examples and practical problems 4 hours per week.</p> <p><i>Assessment:</i> A final exam will be held covering the whole contents of the subject.</p> <p><i>Teacher:</i> Alfonso Orro Arcay y Miguel Rodríguez Bugarín.</p>	6  (4)	3	3

### **GLOSSARY**

**T = Core**

**©<sub>1</sub> = 1<sup>st</sup> Four-month period**

**D = Compulsory**

**©<sub>2</sub> = 2<sup>nd</sup> Four-month period**